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East Central Oklahoma State Univ, Ada

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Management and research information on animal wastes has expanded rapidly in recent years. This material has appeared in such diverse sources as journal articles, conference papers, university publications, government publications, magazine articles, books or book chapters, and theses. This bibliography was compiled in order to speed the flow of information on findings in one segment of the livestock industry to other segments that could benefit from this technology.

Included in this publication are the following indexes: (1) author, (2) keyword, (3) animal information categories. These indexes are followed by a section of abstracts of each reference entry found in the bibliography. Single copies of most articles can be obtained in hard copy or microfiche form at cost from the Animal Waste Technical Information Center, School of Environmental Science, East Central Oklahoma State University, Ada, Oklahoma 74820.

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# LIVESTOCK AND THE ENVIRONMENT

## A Bibliography with Abstracts

## Volume III

by

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Management and research information on animal wastes has expanded rapidly in recent years. This material has appeared in such diverse sources as journal articles, conference papers, university publications, government publications, magazine articles, books or book chapters, and theses. This bibliography was compiled in order to speed the flow of information on findings in one segment of the livestock industry to other segments that could benefit from this technology.

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This report was submitted in fulfillment of Grant Number R801454 by the School of Environmental Science, East Central Oklahoma State University, Ada, Oklahoma under the sponsorship of the Environmental Protection Agency. The work was completed as of January 31, 1976.

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The project staff extends its gratitude to the authors and publishers for use of their publications in these bibliographic entries. Special thanks is also extended to EPA Project Officer R. Douglas Kreis for his assistance in the preparation of this bibliography.

# SECTION I

# INTRODUCTION

Evolving regulations and aims pertaining to pollution abatement and control have necessitated a timely and well-dispersed flow of pertinent information concerning animal waste management so that capital investments in the animal production industry can be made on the basis of the most recent research and operational findings. In many activities, industrial and manufacturing organizations or associations provide the linkage channels through which such information may flow. The wide range in operation sizes and makeup, the geographic distribution of production units, the variations in climatic and geographic factors, and the dictates of the local or regional markets make widespread dissemination of animal waste management information difficult even through the established communication networks such as breed associations, farm organizations, and the popular agricultural press. Common properties and characteristics of animal wastes enable technological transfers to occur in the production operations from one species to another. Publicizing practices of findings in one segment of the livestock production industry can spread new ideas and techniques to other segments of the industry.

The objective of this project is to facilitate the dissemination and technological transfer of information on the management and disposal of animal wastes throughout the livestock industry. Identification and location of pertinent information generated in the production operations of poultry, swine, cattle, fish, and other animals of economic interest raised in open or confined systems is accomplished through searches of technical journals; books; theses; reports from private, state and federal agencies; papers given at meetings of professional societies or symposiums; and articles appearing in the trade or production-oriented "farm" magazines.

The search topics of specific interest include the physical and chemical characteristics of animal wastes (manures and manure contaminated materials); the operational and cost aspects of handling, collection, treatment, storage, transport, utilization, and disposal of animal manures; and the economic and legal impact of these wastes on the problems of air, water, and solid waste pollution. The articles identified in the search are collected and reviewed to determine if the contents are relevant to the project objectives. Those articles that are considered to be of value for the livestock producer or research scientist engaged in animal waste activities are abstracted and added to the collection.

An updated bibliography of animal waste management information is prepared annually. It contains entries and abstracts for all new items maintained in the collection at the Animal Waste Technical Information Center.

It is anticipated that users of this bibliography will secure pertinent publications from local libraries or through interlibrary loan. However, single copies of most publications (those for which copying approval has been obtained from copyright owners) may also be obtained upon request in hard copy or microfiche form at a cost-only fee from the following address:

Mrs. Linda Merryman, Project Librarian
Animal Waste Technical Information Center
School of Environmental Science
East Central Oklahoma State University
Ada, Oklahoma 74820

# SECTION II

## USER'S GUIDE

The entries in this bibliography have been assigned a specific cross reference code. The code number consists of nine digits (example 200-74-2458) arranged in the sequences of a three-digit class code, a two-digit number representing the year of publication or presentation, and a four-digit accession number identifying each article brought into the animal waste information collection. The first grouping identifies the class code of the document according to the following format:

| Code | Class |
|---|---|
| 100 | Technical journal paper |
| 200 | Conference proceeding paper |
| 300 | University or government publication |
| 400 | Magazine article |
| 500 | Book or chapter from a book |
| 600 | Unpublished paper |
| 700 | Thesis |

This publication consists of 4 sections: Author Index, Keyword Index, Animal Information Category Index, and Abstracts. An explanation of each section follows.

### AUTHOR INDEX

This index lists all the authors cited in the bibliography in alphabetical order. To the right of each author entry is the cross reference code of the article or articles with which he is identified. An example of the format is as follows:

| | |
|---|---|
| ADAMS J L | 200 63 2157 |
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## KEYWORD INDEX

This index consists of an alphabetical listing of significant words in an article or in the title of an article. To the right of the keyword are the first 85 characters contained in the title or the title and a listing of keywords, if the title is short. To the left of the keyword is the nine digit cross reference code of the article ascribed to by the keyword. The cross reference code allows the user to enter the bibliography or look up the abstract for additional information about the title. An example of this index format is:

```
200 75 2753    DESIGN               PLANT AND SOIL EFF
200 75 2755    DESIGN               ON LAND DISPOSAL O
200 75 2758    DESIGN               AN OVERLAND FLOW
200 71 1925    DESIGN-CRITERIA      SOIL CONSERVATION
200 71 1932    DESIGN-CRITERIA      SOIL CONSERVATION
200 74 2073    DESIGN-CRITERIA      A FUNDAMENTAL APPR
700 73 2212    DESIGN-CRITERIA      HYDROLOGY OF ANIMA
```

## ANIMAL INFORMATION CATEGORY INDEX

To provide a quick entry into the abstract holdings of the collection, an animal information code was developed. This code utilized an alphabetical entry to signify a broad interest area and a numerical digit to designate a more specific topic under the broad interest area. Each abstract in the collection was classified according to this code and could be listed under the five most relevant categories. This provides the user with an easy entry into the abstract holdings pertaining to his information needs. It is anticipated that some potential users, after reading some of the abstracts listed under these categories, may identify some particular keywords of importance which can be utilized to enter the more comprehensive keyword index to identify abstracts which may pertain to his more specific information needs. The code utilized in this index may be seen on the next page.

## CATEGORIES OF ANIMAL INFORMATION

| Interest Area | Topic Area |
|---|---|
| A. Environmental Effects | 1. General |
| | 2. Surface Runoff from Animal Production Unit Operation |
| | 3. Surface Runoff from Agricultural Watersheds |
| | 4. Groundwater |
| | 5. Odor |
| | 6. Air |
| | 7. Biocides |
| | 8. Vectors |
| | 9. Health |
| | 10. Aesthetics |
| B. Management of Animal Production and Confinement Operations | 1. General |
| | 2. Liquid Systems |
| | 3. Solid Systems |
| C. Characteristics of Animal Wastes | 1. General |
| | 2. Physical |
| | 3. Chemical |
| | 4. Biological |
| | 5. Management's Impact On |
| D. Treatment Processes | 1. General |
| | 2. Physical |
| | 3. Chemical |
| | 4. Biological |
| E. Utilization and Disposal | 1. General |
| | 2. Land |
| | 3. Reuse |
| | 4. By-Product Recovery |
| F. General | 1. Economics |
| | 2. Legalities |
| | 3. Institutional and Policy Needs |
| | 4. Overviews, Trends and Projections |
| | 5. Related Agricultural Operations |

The entries in this index appear by accession number under the code number as found in the following example:

C 1

1664
1689
1710

## ABSTRACTS

This section contains the abstracts of the information entries contained in the bibliography. Most of these abstracts have been published in Selected Water Resources Abstracts published by the Water Resources Scientific Information Center. Each entry, therefore, includes the title of the informational material, the bibliographic citation, the author or authors, keyword identifiers and descriptors, and the abstract. The abstracts are arranged sequentially by an assigned accession number which specifically identifies the article in the collection. To the right of the accession number are the animal information category code numbers assigned to the abstract entry.

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300 74 2255
100 71 2424
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WOODS W D 100 60 2518
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YOUNG R A 200 74 2030
YOUNG R M F 100 74 2585
YOUNG W J 200 70 2394
YOUNGER R L 100 73 2354
YOUNKIN D E 200 75 2693
200 75 2696
YUSHOK W 300 68 2414
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ZINDEL H C 200 69 1840
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ZINDEL J C 200 74 2152
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# SECTION IV

# KEYWORD INDEX

# KEYWORD INDEX

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| 400 | 74 | 1921 | ABANDONED-FEEDLOTS | ABANDONED FEEDLOTS CAN POLLUTE MORE THAN ACTIVE ONES KEYWORDS FEEDLOTS NITROGEN ABANDO |
| 300 | 74 | 1914 | ABATEMENT | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE MA |
| 100 | 67 | 2192 | ABATEMENT | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 300 | 74 | 1914 | ABBATTOIR-WASTES | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE MA |
| 100 | 69 | 2808 | ABORTION | ABORTION IN CATTLE ASSOCIATED WITH THE FEEDING OF POULTRY LITTER KEYWORDS LITTER CATT |
| 200 | 73 | 2101 | ABSOLUTE-HUMIDITY | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 200 | 75 | 2649 | ABSORBED-DRY-MATTE | NUTRITIVE VALUE OF SWINE FECES FOR SWINE KEYWORDS NUTRIENTS REFEEDING SWINE ABSORBED- |
| 100 | 72 | 1657 | ABSORPTION | MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT SLURRY KEYWORDS NITROGEN FERTIL |
| 300 | 74 | 1783 | ABSORPTION | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE P |
| 700 | 74 | 2362 | ABSORPTION | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 700 | 74 | 2405 | ABSORPTION | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 100 | 66 | 2513 | ABSORPTION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION D |
| 100 | 73 | 1905 | ACIDITY | AEROBIC TREATMENT OF PIGGERY WASTE KEYWORDS AEROBIC-TREATMENT SWINE EFFLUENTS SUSPEND |
| 200 | 71 | 1979 | ACTION-PROGRAMS | ACTION PROGRAMS FOR MANURE HANDLING KEYWORDS REGULATION DAIRY-INDUSTRY ECONOMICS ACTI |
| 700 | 65 | 1666 | ACTIVATED-SLUDGE | PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH KEYWORDS OXIDATION-DITCH PERFORMANCE |
| 600 | 73 | 1754 | ACTIVATED-SLUDGE | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING KEYWORDS FEEDLOTS AGRICULTUR |
| 700 | 73 | 2061 | ACTIVATED-SLUDGE | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF KEYWORDS BIOLOGICAL-TREATMENT AGRICULTURAL-RUN |
| 100 | 74 | 2288 | ACTIVATED-SLUDGE | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 700 | 67 | 2363 | ACTIVATED-SLUDGE | ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S |
| 100 | 69 | 2562 | ACTIVATED-SLUDGE | RESEARCH AND PRACTICE IN ANIMAL WASTES TREATMENT KEYWORDS ANIMAL-WASTES WASTE-TREATME |
| 200 | 75 | 2638 | ACTIVATED-SLUDGE | TWO-STAGE ACTIVATED SLUDGE TREATMENT OF EFFLUENT FROM INDUSTRIAL HOG BREEDING FARMS KE |
| 600 | 74 | 2285 | ACTIVATED-SLUDGE-T | POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS KEYWORDS POULTRY WAST |
| 100 | 73 | 2332 | ADAPTATION | ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS KEYWORD |
| 600 | 71 | 1725 | ADDITIVES | ANIMAL WASTE REUSE KEYWORDS RECYCLING FEEDS POULTRY CATTLE PROTEINS INSECTICIDES COST |
| 200 | 73 | 1789 | ADDITIVES | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOUR FEEDS ADDITIVES SAM |
| 100 | 70 | 1823 | ADDITIVES | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE KEYWORDS FEEDS ADD |
| 200 | 69 | 1824 | ADDITIVES | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
| 200 | 74 | 1869 | ADDITIVES | RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM KEYWORDS RECYCLING DRIED-P |
| 400 | 73 | 1922 | ADDITIVES | KAOLIN RESULTS IN DRIER DROPPINGS KEYWORDS POULTRY ADDITIVES EXCRETA KAOLIN FLY-CONTR |
| 400 | 75 | 2343 | ADDITIVES | AG ENGINEERS REVIEW NEW WASTE MANAGEMENT SYSTEMS KEYWORDS POULTRY NUTRIENTS ADDITIVES |
| 100 | 73 | 2354 | ADDITIVES | HORN FLIES STABLE FLIES AND HOUSE FLIES-DEVELOPMENT IN FECES OF BOVINES TREATED ORALLY |
| 200 | 75 | 2682 | ADDITIVES | INFLUENCE OF ANTIBIOTICS AND GROWTH PROMOTING FEED ADDITIVES ON THE MANURING EFFECT OF |
| 200 | 75 | 2695 | ADDITIVES | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WAST |
| 100 | 73 | 1790 | ADHESIVES | A FAECES COLLECTOR SUITABLE FOR MALE CALVES KEYWORDS CATTLE FAECES-COLLECTOR MALE-CAL |
| 100 | 66 | 2513 | ADSORPTION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION D |
| 300 | 72 | 1647 | ADULTICIDES | HOUSE FLY CONTROL IN CAGED LAYER HOUSES KEYWORDS LARVAE FLY-CONTROL CAGED-LAYERS-HOUS |
| 100 | 72 | 2759 | ADVANTAGES | HIGH RISE POULTRY HOUSES KEYWORDS ECONOMICS ODOR HIGH-RISE-POUTRY-HOUSES NEW-ZEALAND |
| 200 | 75 | 2633 | AERATED-BASIN | TOTAL WASTE MANAGEMENT FOR A LARGE SWINE PRODUCTION FACILITY KEYWORDS COSTS SPRINKLER- |
| 600 | 71 | 1717 | AERATED-LAGOONS | AEROBIC WASTE TREATMENT KEYWORDS AEROBIC-TREATMENT OXIDATION-LAGOONS AERATED-LAGOONS |
| 200 | 71 | 1976 | AERATED-LAGOONS | RESEARCH PROGRESS IN MANURE HANDLING AND TREATMENT SYSTEMS FOR LIVESTOCK KEYWORDS MA |
| 300 | 71 | 2062 | AERATED-LAGOONS | MANAGEMENT OF DAIRY CATTLE WASTES BY THE DEEP AERATED LAGOON AND IRRIGATION ONTO SOILS |
| 100 | 74 | 2288 | AERATED-LAGOONS | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 100 | 72 | 2550 | AERATED-LAGOONS | TREATMENT OF DAIRY WASTES BY MECHANISED BIOLOGICAL METHODS KEYWORDS WASTE-TREATMENT DA |
| 200 | 74 | 1867 | AERATED-POND | SURMOUNTING THE POULTRY WASTE PROBLEM KEYWORDS POULTRY EXCRETA WASTE-MANAGEMENT ANAER |
| 300 | 68 | 1625 | AERATION | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 100 | 73 | 1635 | AERATION | MINIMUM AERATION FOR CONTROL OF ODORS FROM SWINE WASTES KEYWORDS AERATION ODOR-CONTROL |
| 200 | 66 | 1644 | AERATION | TREATMENT OF ANIMAL WASTES AT THE GREENFIELD LABORATORIES OF ELI LILLY AND COMPANY KEY |
| 700 | 73 | 1652 | AERATION | DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS WASTE-TREATMENT AGR |
| 100 | 72 | 1661 | AERATION | OXIDATION WHEEL ELIMINATES ODORS MANURE HANDLING AND POLLUTION KEYWORDS WASTE-HANDLIN |
| 700 | 65 | 1666 | AERATION | PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH KEYWORDS OXIDATION-DITCH PERFORMANCE |
| 700 | 70 | 1736 | AERATION | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 600 | 72 | 1752 | AERATION | ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE KEYWORDS AERATION LARVAE F |
| 700 | 68 | 1837 | AERATION | A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM A |
| 300 | 71 | 1866 | AERATION | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 300 | 74 | 1891 | AERATION | A WASTE TREATMENT SYSTEM FOR CONFINED HOG RAISING OPERATIONS KEYWORDS SWINE WASTE-TRE |
| 100 | 74 | 1912 | AERATION | AERATION OF POULTRY WASTES FOR ODOR AND NITROGEN CONTROL KEYWORDS POULTRY AERATION NIT |
| 200 | 74 | 2027 | AERATION | OXIDATION DITCH SYSTEM ANALYSIS AND FIELD EVALUATION OF THE AEROB-A-JET KEYWORDS ANAL |
| 100 | 74 | 2045 | AERATION | CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN STORED DAIRY MANURE KEYWOR |
| 200 | 74 | 2150 | AERATION | FLUSHING SWINE WASTE KEYWORDS AERATION RECYCLING ODOR COSTS SWINE FLUSHING SLOTTED-FL |
| 200 | 63 | 2165 | AERATION | UTILIZATION AND DISPOSAL OF POULTRY MANURE KEYWORDS POULTRY WASTE-DISPOSAL AERATION M |
| 100 | 72 | 2186 | AERATION | HANDLING MILKING PARLOR WASTE KEYWORDS DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM |
| 100 | 74 | 2189 | AERATION | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 100 | 72 | 2197 | AERATION | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KE |
| 600 | 67 | 2198 | AERATION | STORAGE OF POULTRY MANURE WITH MINIMUM ODOR KEYWORDS WASTE-STORAGE POULTRY ODOR OXIDAT |
| 100 | 74 | 2223 | AERATION | COMPARISON OF THE CONVENTIONAL CAGE ROTOR AND JET-AERO-MIX SYSTEMS IN OXIDATION DITCH |
| 400 | 71 | 2238 | AERATION | TWO STAGE DRYING FOR MANURE DISPOSAL ADVOCATED BY PENN STATE POULTRYMAN KEYWORDS DRYI |
| 200 | 67 | 2281 | AERATION | EVALUATION OF AERATED LAGOONS AS A MEANS OF SWINE WASTE STABILIZATION KEYWORDS AEROBI |
| 400 | 72 | 2290 | AERATION | NEW WASTE TREATMENT SYSTEM IS USED FOR HOGS KEYWORDS WASTE-TREATMENT SEPARATION-TECHNI |
| 400 | 72 | 2297 | AERATION | MANURE HOLDING POND ODOR CONTROL KEYWORDS AERATION SIZE MANURE-HOLDING-POND ODOR-CONT |
| 700 | 67 | 2363 | AERATION | ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S |
| 700 | 73 | 2379 | AERATION | OXYGEN TRANSFER RELATIONSHIPS IN A POULTRY WASTE MIXED LIQUOR KEYWORDS WASTE-TREATMEN |
| 100 | 71 | 2402 | AERATION | BIODEGRADATION OF PIG WASTE BREAKDOWN OF SOLUBLE NITROGEN COMPOUNDS AND THE EFFECT OF C |
| 400 | 73 | 2416 | AERATION | POULTRY MANURE COMPOSTING KEYWORDS AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST |
| 200 | 73 | 2437 | AERATION | OXYGENATION AND FLOW CHARACTERISTICS OF MECHANICAL AERATORS KEYWORDS AERATION OXYGENAT |
| 200 | 75 | 2604 | AERATION | TECHNIQUES THAT ARE SOLVING POLLUTION PROBLEMS FOR POULTRYMEN KEYWORDS POULTRY WASTE- |
| 200 | 75 | 2612 | AERATION | OPERATION OF A BEEF MANURE FLUSHING SYSTEM IN A COLD CLIMATE KEYWORDS CONFINEMENT-PENS |
| 200 | 75 | 2700 | AERATION | IF YOU CANNOT SPREAD IT TREAT IT KEYWORDS SLURRIES WASTE-TREATMENT SEPARATION-TECHNIQ |
| 200 | 75 | 2717 | AERATION | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 200 | 75 | 2729 | AERATION | LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES KEYWORDS LIQUID-WASTES EQUIPMENT AER |
| 200 | 75 | 2744 | AERATION | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 200 | 75 | 2745 | AERATION | SURFACE AERATION-DESIGN AN PERFORMANCE FOR LAGOONS KEYWORDS AERATION DESIGN PERFORMAN |
| 700 | 74 | 2766 | AERATION | AQUATIC ECOLOGY OF SWINE WASTE LAGOONS BEFORE AND AFTER ARTIFICIAL AERATION KEYWORDS |
| 100 | 71 | 2787 | AERATION | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 200 | 73 | 2480 | AERATORS | AEROBIC TREATMENT OF LIVESTOCK WASTES KEYWORDS AEROBIC-TREATMENT LIVESTOCK DESIGN ONG |
| 300 | 68 | 1625 | AEROBIC-BACTERIA | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 100 | 72 | 1667 | AEROBIC-BACTERIA | THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES KEYWORDS THERMOPHI |
| 300 | 61 | 2326 | AEROBIC-BACTERIA | INDOOR LAGOON FOR POULTRY MANURE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL WASTE-TREAT |
| 100 | 72 | 1675 | AEROBIC-CONDITIONS | NUTRITIVE VALUE OF AEROBICALLY SUSTAINED SWINE EXCREMENT KEYWORDS NUTRIENTS SWINE EXCR |
| 200 | 64 | 1695 | AEROBIC-CONDITIONS | IDENTIFICATION AND CONTROL OF ODORS FROM ANIMAL WASTES KEYWORDS ODOR-CONTROL ANAEROBIC |
| 700 | 71 | 1742 | AEROBIC-CONDITIONS | A COMPARISON OF AN AERATED LAGOON AND IRRIGATION SYSTEM WITH A CONVENTIONAL SYSTEM FOR |
| 200 | 69 | 1760 | AEROBIC-CONDITIONS | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 700 | 71 | 1762 | AEROBIC-CONDITIONS | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |
| 700 | 70 | 1779 | AEROBIC-CONDITIONS | THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS KEYWORDS NITROGEN FEEDLOTS SOILS CAT |
| 200 | 70 | 1805 | AEROBIC-CONDITIONS | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 400 | 73 | 1820 | AEROBIC-CONDITIONS | GRASS FILTER SYSTEMS ANOTHER NEW RUNOFF CONTROL METHOD KEYWORDS WASTE-TREATMENT WASTE- |
| 400 | 74 | 1827 | AEROBIC-CONDITIONS | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AIR |
| 300 | | 1829 | AEROBIC-CONDITIONS | THE TREATMENT OF MANURE IN OXIDATION DITCHES KEYWORDS WASTE-TREATMENT MANURE OXIDATION |
| 600 | 73 | 1844 | AEROBIC-CONDITIONS | FORMS OF NITROGEN IN ANIMAL WASTE KEYWORDS NITROGEN-COMPOUNDS WASTE-TREATMENT WASTE-S |
| 100 | 71 | 1902 | AEROBIC-CONDITIONS | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 700 | 69 | 2181 | AEROBIC-CONDITIONS | AEROBIC STORAGE OF DAIRY CATTLE MANURE KEYWORDS WASTE-STORAGE AEROBIC-CONDITIONS DAIR |

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| 400 | | 2191 | AEROBIC-CONDITIONS | HOW EGGMEN ARE SOLVING THE ECOLOGY PROBLEM KEYWORDS POULTRY ECOLOGY WASTE-STORAGE WAS |
| 400 | 75 | 2324 | AEROBIC-CONDITIONS | WASTE CONVERSION CONCEPT DEVELOPED KEYWORDS RECYCLING AEROBIC-CONDITIONS BACTERIA CAT |
| 300 | 73 | 2407 | AEROBIC-CONDITIONS | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS EFFLUE |
| 200 | 73 | 2440 | AEROBIC-CONDITIONS | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
| 200 | 74 | 2458 | AEROBIC-CONDITIONS | THE MECHANICS OF AIR DRYING KEYWORDS POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB |
| 300 | 63 | 2471 | AEROBIC-CONDITIONS | MANURE DISPOSAL LAGOONS KEYWORDS WASTE-DISPOSAL AEROBIC-CONDITIONS ANAEROBIC-CONDITIO |
| 300 | | 2496 | AEROBIC-CONDITIONS | KSU AEROBIC SWINE WASTE HANDLING SYSTEM-6 YEARS OF PROBLEMS AND PROGRESS KEYWORDS KAN |
| 200 | 75 | 2617 | AEROBIC-CONDITIONS | WASTE MANAGEMENT AT HALL BROTHERS DAIRY KEYWORDS DAIRY-INDUSTRY CONFINEMENT-PENS SEPAR |
| 200 | 75 | 2725 | AEROBIC-CONDITIONS | AEROBIC COMPOSTING-NEW BUILT-UP BED TECHNIQUE KEYWORDS AEROBIC-CONDITIONS EQUIPMENT DE |
| 700 | 71 | 1668 | AEROBIC-DIGESTION | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 400 | 74 | 1797 | AEROBIC-DIGESTION | WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF KEYWORDS FARM-WASTES WASTE-DISPOSAL |
| 300 | 74 | 1891 | AEROBIC-DIGESTION | A WASTE TREATMENT SYSTEM FOR CONFINED HOG RAISING OPERATIONS KEYWORDS SWINE WASTE-TRE |
| 700 | 67 | 2236 | AEROBIC-DIGESTION | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 400 | 75 | 2322 | AEROBIC-DIGESTION | NEW MANURE CONVERSION PLANT OPENED KEYWORDS RECYCLING FERTILIZERS FEEDS AEROBIC-DIGES |
| 400 | 71 | 2494 | AEROBIC-DIGESTION | WHY WASTE ANIMAL WASTES KEYWORDS WASTE-DISPOSAL RECYCLING LAGOONS ANIMAL-WASTES ECOLI |
| 300 | 74 | 1796 | AEROBIC-LAGOONS | LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS KEYWORDS LIQUID-WASTES MANAGEMENT SWINE |
| 300 | 74 | 2177 | AEROBIC-LAGOONS | RECYCLING POULTRY WASTE AS FEED WILL IT PAY KEYWORDS RECYCLING FEEDS ECONOMICS INCINER |
| 200 | 67 | 2281 | AEROBIC-LAGOONS | EVALUATION OF AERATED LAGOONS AS A MEANS OF SWINE WASTE STABILIZATION KEYWORDS AEROBI |
| 200 | 74 | 2005 | AEROBIC-LAGOON | INTEGRATED POULTRY MANURE HANDLING USING FLUSH TRAYS UNDER CAGES AND RENOVATED WASTEWA |
| 200 | 73 | 2477 | AEROBIC-PIT | EFFECTS OF WASTE MANAGEMENT SYSTEMS ON THE ANIMALS ENVIRONMENT KEYWORDS CONFINEMENT-P |
| 400 | 74 | 1911 | AEROBIC-POND | A CLOSED SYSTEM NEW IDEA IN POULTRY WASTE DISPOSAL KEYWORDS POULTRY RECYCLING EXCRETA |
| 200 | 64 | 1693 | AEROBIC-STABILIZAT | PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL-AEROBIC STABILI |
| 200 | 75 | 2743 | AEROBIC-STABILIZAT | BIOLOGICALLY-CONTROLLED LOADING OF AEROBIC STABILIZATION PLANTS KEYWORDS DESIGN-CRITE |
| 300 | 74 | 1627 | AEROBIC-TREATMENT | ANAEROBIC AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES KEYWORDS AEROBIC-TREATMENT A |
| 700 | 67 | 1651 | AEROBIC-TREATMENT | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 600 | 74 | 1686 | AEROBIC-TREATMENT | AEROBIC TREATMENT OF POULTRY WASTES KEYWORDS AEROBIC-TREATMENT FARM-WASTES POULTRY DU |
| 700 | 71 | 1688 | AEROBIC-TREATMENT | THE AEROBIC DECOMPOSITION OF SOLID BEEF CATTLE FEEDLOT WASTE KEYWORDS AEROBIC-TREATME |
| 200 | 64 | 1693 | AEROBIC-TREATMENT | PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL-AEROBIC STABILI |
| 600 | 71 | 1717 | AEROBIC-TREATMENT | AEROBIC WASTE TREATMENT KEYWORDS AEROBIC-TREATMENT OXIDATION-LAGOONS AERATED-LAGOONS |
| 200 | 72 | 1795 | AEROBIC-TREATMENT | HARVESTING NUTRIENTS FROM SWINE WASTES KEYWORDS NUTRIENTS SWINE WASTE-TREATMENT OXIDA |
| 400 | 72 | 1842 | AEROBIC-TREATMENT | WLJ PREVIEWS FIRST COMMERCIAL MANURE SYSTEM KEYWORDS AEROBIC-TREATMENT LICOM-WASTE-TRE |
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200 73 2438   AGRICULTURAL-RUNOF DESIGN AND CONSTRUCTION OF HOLDING PONDS AND LAGOONS  KEYWORDS  WASTE-DISPOSAL LAGOONS
200 73 2442   AGRICULTURAL-RUNOF DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND  KEYWORDS  FARM-WASTES LI
200 73 2444   AGRICULTURAL-RUNOF MY WASTE HANDLING SYSTEM FOR BEEF  KEYWORDS  AGRICULTURAL-RUNOFF WATER-POLLUTION FEEDLO
200 73 2446   AGRICULTURAL-RUNOF LIVESTOCK WASTE MANAGEMENT IN A QUALITY ENVIRONMENT KEYWORDS  FEEDLOTS LIVESTOCK AGRICU
100 73 2447   AGRICULTURAL-RUNOF SOIL WATER NITRATE BENEATH A BROAD BASIN TERRACED FEEDLOT KEYWORDS  SOIL-WATER NITRATES
200 73 2473   AGRICULTURAL-RUNOF HYDROLOGY OF OPEN FEEDLOTS IN THE CORNBELT  KEYWORDS HYDROLOGY FEEDLOTS CORN-BELT RAINF
200 73 2475   AGRICULTURAL-RUNOF OUTDOOR UNPAVED FEEDLOT MANAGEMENT  KEYWORDS  FEEDLOTS DESIGN AGRICULTURAL-RUNOFF DRAIN
200 73 2486   AGRICULTURAL-RUNOF SUMMARY OF KANSAS EXPERIENCE WITH LIQUID WASTE SPREADING KEYWORDS  KANSAS AGRICULTURAL-
100 74 2491   AGRICULTURAL-RUNOF SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY C
300 75 2495   AGRICULTURAL-RUNOF RESEARCH STATUS ON EFFECTS OF LAND APPLICATION OF ANIMAL WASTES  KEYWORDS  SOIL-DISPOSA
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| | | | | |
|---|---|---|---|---|
| 300 | 75 | 2507 | AGRICULTURAL-RUNOF | MANAGE MANURE FOR ITS VALUE KEYWORDS SOLID-WASTES LIQUID-WASTES CROP-RESPONSE ODOR |
| 400 | 75 | 2508 | AGRICULTURAL-RUNOF | EMERGING ISSUES IN FEEDLOT WASTE MANAGEMENT KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF RECY |
| 300 | 73 | 2516 | AGRICULTURAL-RUNOF | IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS KEYWORDS MICHIGAN DAIRY-INDUSTRY LEGAL |
| 300 | 71 | 2523 | AGRICULTURAL-RUNOF | FEEDLOT WASTE DISPOSAL AND WATER POLLUTION KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF WATE |
| 500 | 71 | 2524 | AGRICULTURAL-RUNOF | POLLUTION CONTROL TECHNIQUES AND REQUIREMENTS KEYWORDS REGULATION ILLINOIS AGRICULTURA |
| 400 | 69 | 2540 | AGRICULTURAL-RUNOF | APPLY MORE NOT LESS POULTRY LITTER TO REDUCE POLLUTION KEYWORDS AGRICULTURAL-RUNOFF AR |
| 300 | 74 | 2556 | AGRICULTURAL-RUNOF | WATER QUALITY AND SOIL EROSION FROM SURFACE APPLICATION OF TREATED LIQUID SWINE WASTE |
| 600 | 75 | 2559 | AGRICULTURAL-RUNOF | COMPARISON OF DESIGN CRITERIA AND PERFORMANCE OF WASTE HANDLING SYSTEMS KEYWORDS DESI |
| 700 | 73 | 2563 | AGRICULTURAL-RUNOF | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO A FORAGE SORGHUM KEYWORDS AGRICULTUR |
| 200 | 64 | 2567 | AGRICULTURAL-RUNOF | STREAM POLLUTION FROM FEEDLOT RUNOFF KEYWORDS WATER-POLLUTION AGRICULTURAL-RUNOFF FEE |
| 400 | 75 | 2575 | AGRICULTURAL-RUNOF | HE USES VALUABLE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF DRAINAGE FEEDLOTS FERTILIZERS CO |
| 200 | 75 | 2595 | AGRICULTURAL-RUNOF | ECONOMIC IMPACTS OF ALTERNATIVE WATER POLLUTION CONTROL RULES ON BEEF FEEDLOTS OF LESS |
| 200 | 75 | 2597 | AGRICULTURAL-RUNOF | ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTION CONTROL RULES ON THE UNITED STATES |
| 200 | 75 | 2609 | AGRICULTURAL-RUNOF | MANAGEMENT OF RUNOFF WATER IN RELATION TO FEEDLOT OPERATIONS KEYWORDS AGRICULTURAL-RUN |
| 200 | 75 | 2614 | AGRICULTURAL-RUNOF | EVALUATION OF DAIRY BEEF AND SWINE WASTE HANDLING SYSTEMS KEYWORDS LIVESTOCK DAIRY-IND |
| 200 | 75 | 2661 | AGRICULTURAL-RUNOF | DIRECT LAND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF NUTRIENTS LAND-DI |
| 200 | 75 | 2663 | AGRICULTURAL-RUNOF | DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND KEYWORDS FEEDLOTS CATTLE KANSAS CROP-RESPONS |
| 200 | 75 | 2665 | AGRICULTURAL-RUNOF | MANURE FROM CAGED HENS EVALUATED ON FESCUE PASTURE KEYWORDS POULTRY FESCUES CROP-RESPO |
| 200 | 75 | 2671 | AGRICULTURAL-RUNOF | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 200 | 75 | 2672 | AGRICULTURAL-RUNOF | NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS KEYWORDS WINTER AGRICUL |
| 200 | 75 | 2674 | AGRICULTURAL-RUNOF | EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED |
| 200 | 75 | 2706 | AGRICULTURAL-RUNOF | ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS KEYWORDS AGRICUL |
| 200 | 75 | 2708 | AGRICULTURAL-RUNOF | MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES KEYWORDS IR |
| 200 | 75 | 2709 | AGRICULTURAL-RUNOF | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA KEYWORDS AGRIC |
| 200 | 75 | 2710 | AGRICULTURAL-RUNOF | DESIGN RUNOFF VOLUME FROM FEEDLOTS IN THE SOUTHWESTERN GREAT PLAINS KEYWORDS DESIGN A |
| 200 | 75 | 2711 | AGRICULTURAL-RUNOF | QUANTITY AND QUALITY OF BEEF FEEDYARD RUNOFF IN THE GREAT PLAINS KEYWORDS AGRICULTURA |
| 200 | 75 | 2751 | AGRICULTURAL-RUNOF | DISPOSAL OF DAIRY CATTLE MANURE ON SOIL KEYWORDS DAIRY-INDUSTRY CATTLE SOILS CROP-RES |
| 200 | 75 | 2753 | AGRICULTURAL-RUNOF | PLANT AND SOIL EFFECTS OF SWINE LAGOON EFFLUENT APPLIED TO COASTAL BERMUDAGRASS KEYWO |
| 700 | 71 | 2771 | AGRICULTURAL-RUNOF | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 700 | 73 | 2772 | AGRICULTURAL-RUNOF | ECONOMICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS COMPLYING WITH POLLUTION-CONTROL-REGU |
| 600 | 71 | 2778 | AGRICULTURAL-RUNOF | A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT |
| 700 | 70 | 2781 | AGRICULTURAL-RUNOF | AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS KEYWOR |
| 100 | 70 | 2786 | AGRICULTURAL-RUNOF | TREATMENT AND DISPOSAL OF ANIMAL WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL ANIMA |
| 300 | 69 | 2797 | AGRICULTURAL-RUNOF | MANAGEMENT AND CONTROL OF BEEF FEEDLOT WASTE KEYWORDS FEEDLOTS CATTLE NEBRASKA REGULAT |
| 400 | 70 | 2803 | AGRICULTURAL-RUNOF | FEEDLOT POLLUTION-A SOLVABLE PROBLEM KEYWORDS AGRICULTURAL-RUNOFF WATER-POLLUTION SOU |
| 100 | 72 | 2811 | AGRICULTURAL-RUNOF | THE USE OF ANIMAL WASTES ON FERTILIZER KEYWORDS FERTILIZERS IRRIGATION ANIMAL-WASTES |
| 400 | 74 | 1630 | AGRICULTURAL-WASTE | MANURE AS A FUEL KEYWORDS FUELS MANURE WASTE-TREATMENT WASTE-DISPOSAL COMPOSTING AGRI |
| 100 | 73 | 1833 | AGRICULTURAL-WASTE | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 300 | 74 | 1876 | AGRICULTURAL-WASTE | FEASIBILITY OF OVERLAND FLOW TREATMENT OF FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF |
| 300 | 73 | 1907 | AGRICULTURAL-WASTE | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 200 | 72 | 1908 | AGRICULTURAL-WASTE | A STATUS REPORT ON AGRICULTURAL AND MUNICIPAL WASTE TREATMENT LAGOONS IN MISSISSIPPI K |
| 200 | 74 | 1986 | AGRICULTURAL-WASTE | DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS WASTE-DISPOSAL RE |
| 200 | 74 | 2017 | AGRICULTURAL-WASTE | EUROPEAN APPROACHES TO THE CONTROL OF WATER POLLUTION PROBLEMS CAUSED BY AGRICULTURAL W |
| 600 | 74 | 2072 | AGRICULTURAL-WASTE | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 100 | 74 | 2126 | AGRICULTURAL-WASTE | AGRICULTURAL WASTES KEYWORDS LIVESTOCK PROPERTIES WASTE-TREATMENT REFEEDING LAND-DISP |
| 500 | 74 | 2132 | AGRICULTURAL-WASTE | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
| 100 | 74 | 2288 | AGRICULTURAL-WASTE | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 300 | 72 | 2313 | AGRICULTURAL-WASTE | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 72 | 2328 | AGRICULTURAL-WASTE | THE OIL CONVERSION PROCESS-AN ASSESSMENT KEYWORDS RECYCLING OIL LIVESTOCK AGRICULTURAL |
| 100 | 72 | 2329 | AGRICULTURAL-WASTE | CONVERTING ORGANIC WASTES TO OIL KEYWORDS RECYCLING ORGANIC-WASTES OIL CELLULOSE CATT |
| 400 | 75 | 2330 | AGRICULTURAL-WASTE | BRITISH GROUP ENCOURAGING WASTE RECYCLING KEYWORDS RECYCLING FARM-WASTES GREAT-BRITAIN |
| 100 | 72 | 2357 | AGRICULTURAL-WASTE | MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES KEYWORDS MICROBIAL |
| 100 | 70 | 2389 | AGRICULTURAL-WASTE | INDUSTRIAL AND AGRICULTURAL SOLID WASTES AND PROBLEMS INVOLVED IN THEIR DISPOSAL KEYWO |
| 400 | 72 | 2415 | AGRICULTURAL-WASTE | CRITICAL WASTE PROBLEMS AHEAD KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL LAGOONS REC |
| 200 | 71 | 2453 | AGRICULTURAL-WASTE | AGRICULTURAL WASTES IN ARID ZONES KEYWORDS AGRICULTURAL-WASTES DOMESTIC-WASTES WATER- |
| 200 | 64 | 2565 | AGRICULTURAL-WASTE | SANITARY ENGINEERING IN AGRICULTURE KEYWORDS DRYING ODOR LAGOONS AGRICULTURAL-WASTES |
| 100 | 74 | 2585 | AGRICULTURAL-WASTE | POLLUTION EFFECTS ON SURFACE AND GROUND WATERS KEYWORDS WATER-POLLUTION-SOURCES NUTRIE |
| 100 | 70 | 2769 | AGRICULTURAL-WASTE | THE DISPOSAL OF INTRACTABLE INDUSTRIAL AND AGRICULTURAL WASTES-CONCLUSION KEYWORDS AG |
| 100 | 72 | 2800 | AGRICULTURAL-WASTE | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 100 | 71 | 2807 | AGRICULTURAL-WASTE | INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIAL |
| 300 | 72 | 1658 | AGRICULTURE | CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM AGRICULTURAL LANDS KEYWORDS SEDIMENT-C |
| 300 | 74 | 1860 | AGRICULTURE | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 300 | 71 | 1866 | AGRICULTURE | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 100 | 71 | 1872 | AGRICULTURE | AGRICULTURE THE SEEDS OF A PROBLEM KEYWORDS AGRICULTURE FARM-WASTES FORESTRY WASTE-DI |
| 200 | 74 | 19 7 | AGRICULTURE | METHODS FOR IDENTIFYING AND EVALUATING THE NATURE AND EXTENT OF NONPOINT SOURCES OF POL |
| 300 | 71 | 2077 | AGRICULTURE | AIR POLLUTION AND AGRICULTURE KEYWORDS AGRICULTURE AIR-POLLUTION ARIZONA POLLUTANTS S |
| 100 | 73 | 2176 | AGRICULTURE | RECYCLING ENERGY AND AGRICULTURAL ECONOMICS KEYWORDS RECYCLING ECONOMICS AGRICULTURE E |
| 100 | 67 | 2192 | AGRICULTURE | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 200 | 71 | 2206 | AGRICULTURE | PRINCIPLES OF NUTRIENT CONTROL FOR AGRICULTURAL WASTEWATERS KEYWORDS NUTRIENTS CONTRO |
| 100 | 71 | 2358 | AGRICULTURE | INDUSTRIAL WASTE AND AGRICULTURE IN GLAMORGAN KEYWORDS INDUSTRIAL-WASTES AGRICULTURE R |
| 200 | 70 | 2396 | AGRICULTURE | AN ASSESSMENT OF THE AGRICULTURAL AND PROCESSING WASTE PROBLEMS AND CONTROL IN WEST VIR |
| 200 | 70 | 2398 | AGRICULTURE | ROLE OF AGRICULTURE IN THE QUALITY OF THE NEW HAMPSHIRE ENVIRONMENT KEYWORDS AGRICULT |
| 300 | 70 | 2497 | AGRICULTURE | AGRICULTURE AND THE POLLUTION PROBLEM KEYWORDS AGRICULTURE WATER-POLLUTION-CONTROL WA |
| 200 | 70 | 2506 | AGRICULTURE | AGRICULTURE AND NATURES NUTRIENT CYCLES KEYWORDS AGRICULTURE WATER-POLLUTION NITROGEN |
| 300 | 74 | 1914 | AGRICULTURE-WASTES | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE MA |
| 200 | 73 | 2489 | AGRONOMY | AGRONOMIC CONSIDERATIONS OF ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL AGRONOMY CR |
| 600 | 72 | 2073 | AIR | DRYING PARAMETERS OF FORMED POULTRY EXCRETA KEYWORDS DRYING POULTRY TEMPERATURE AIR EQ |
| 700 | 65 | 2188 | AIR-BORNE-BACTERIA | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 400 | 75 | 2038 | AIR-DRYING | POULTRY WASTE FOR CATFISH KEYWORDS CATFISHES DIETS PERFORMANCE PROTEINS POULTRY-WASTE |
| 200 | 74 | 2458 | AIR-DRYING | THE MECHANICS OF AIR DRYING KEYWORDS POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB |
| 300 | 74 | 2428 | AIR-INLETS | UNDERFLOOR VENTILATION FOR SLOTTED FLOOR SWINE BUILDINGS KEYWORDS VENTILATION DESIGN C |
| 100 | 72 | 1621 | AIR-POLLUTION | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 300 | 74 | 1629 | AIR-POLLUTION | CONTROL OF DUST FROM CATTLE FEEDLOTS KEYWORDS CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN |
| 400 | 71 | 1641 | AIR-POLLUTION | TEST SWINE WASTE DISPOSAL SYSTEMS KEYWORDS SWINE WASTE-DISPOSAL TESTING WATER-POLLUTI |
| 200 | 73 | 1648 | AIR-POLLUTION | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 400 | 74 | 1769 | AIR-POLLUTION | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 300 | 73 | 1785 | AIR-POLLUTION | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 200 | 73 | 1789 | AIR-POLLUTION | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAN |
| 400 | 74 | [illegible] | AIR-POLLUTION | MONFORT FUELS FEEDLOT AND PLANT WITH MANURE KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA |
| 100 | 70 | 1814 | AIR-POLLUTION | FEEDLOT POLLUTION KEYWORDS FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION |
| 700 | 68 | 1826 | AIR-POLLUTION | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 300 | 74 | 1889 | AIR-POLLUTION | AGRICULTURAL ANIMALS AND THE ENVIRONMENT KEYWORDS FEEDLOTS MANAGEMENT AIR-POLLUTION W |
| 200 | 74 | 1987 | AIR-POLLUTION | BEEF CATTLE FEEDLOTS-IMPACT ON UNDERLYING SOIL KEYWORDS SOIL-PROFILES GROUNDWATER FEED |
| 200 | 74 | 2008 | AIR-POLLUTION | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 300 | 71 | 2076 | AIR-POLLUTION | BEEF FEEDLOTS-A POLLUTION PROBLEM KEYWORDS FEEDLOTS MANAGEMENT WATER-POLLUTION AIR-PO |
| 300 | 71 | 2077 | AIR-POLLUTION | AIR POLLUTION AND AGRICULTURE KEYWORDS AGRICULTURE AIR-POLLUTION ARIZONA POLLUTANTS S |
| 300 | 71 | 2080 | AIR-POLLUTION | A SUMMARY OF STATE REGULATIONS PERTAINING TO ANIMAL WASTE MANAGEMENT IN THE NORTH CENTR |
| 300 | 72 | 2087 | AIR-POLLUTION | DUST AND ODOR PROBLEMS OF THE FEEDLOT KEYWORDS ODOR DUST FEEDLOTS AIR-POLLUTION LEGA |
| 200 | 73 | 2101 | AIR-POLLUTION | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 500 | 74 | 2132 | AIR-POLLUTION | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |

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| 200 | 74 | 2139 | AIR-POLLUTION | ODOR PROBLEMS ASSOCIATED WITH AGRICULTURAL WASTE HANDLING KEYWORDS ODOR MICHIGAN AIR-P |
| 200 | 74 | 2141 | AIR-POLLUTION | MICHIGAN S ENVIRONMENTAL CONTROL PROGRAM AND ORGANIZATION KEYWORDS MICHIGAN WATER-POLL |
| 200 | 63 | 2166 | AIR-POLLUTION | ODORS AND AIR POLLUTION KEYWORDS WASTES POULTRY AIR-POLLUTION ODOR ODOR-CONTROL ODOR- |
| 200 | 72 | 2174 | AIR-POLLUTION | A SYSTEMS APPROACH TO CATTLE FEEDLOT POLLUTION CONTROL KEYWORDS CATTLE FEEDLOTS WATER- |
| 700 | 65 | 2188 | AIR-POLLUTION | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 100 | 67 | 2192 | AIR-POLLUTION | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 100 | 71 | 2200 | AIR-POLLUTION | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 | 64 | 2204 | AIR-POLLUTION | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 100 | 74 | 2296 | AIR-POLLUTION | DIURNAL FLUCTUATION AND MOVEMENT OF ATMOSPHERIC AMMONIA AND RELATED GASES FROM DAIRIES |
| 200 | 70 | 2396 | AIR-POLLUTION | AN ASSESSMENT OF THE AGRICULTURAL AND PROCESSING WASTE PROBLEMS AND CONTROL IN WEST VIR |
| 300 | 72 | 2561 | AIR-POLLUTION | WASTE MANAGEMENT PRACTICES AND SYSTEMS ON MICHIGAN DAIRY FARMS KEYWORDS MICHIGAN REGU |
| 200 | 75 | 2586 | AIR-POLLUTION | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS DA |
| 200 | 75 | 2601 | AIR-POLLUTION | LEGAL ASPECTS OF ODOR POLLUTION CONTROL KEYWORDS AIR-POLLUTION LEGISLATION FEEDLOTS L |
| 200 | 75 | 2693 | AIR-POLLUTION | EXHAUST SYSTEMS FOR UNDERFLOOR LIQUID MANURE PITS KEYWORDS ODOR AIR-POLLUTION DESIGN |
| 200 | 75 | 2713 | AIR-POLLUTION | MANAGEMENT OF A FLUSHING GUTTER MANURE REMOVAL SYSTEM TO IMPROVE ATMOSPHERIC QUALITY IN |
| 100 | 72 | 2790 | AIR-POLLUTION | RETORTING FEEDLOT WASTES KEYWORDS FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO |
| 300 | 75 | 2335 | AIR-POLLUTION-CONT | ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES KEYWORDS LEGAL-ASPECTS REGULATION DAIR |
| 200 | 75 | 2713 | AIR-QUALITY | MANAGEMENT OF A FLUSHING GUTTER MANURE REMOVAL SYSTEM TO IMPROVE ATMOSPHERIC QUALITY IN |
| 600 | 72 | 1992 | AIR-TEMPERATURE | EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM KEYWORDS CLIMATOLOGY FEEDL |
| 200 | 74 | 2035 | AIR-WASHERS | POSSIBLE WAYS OF ABATING THE NUISANCE OF SMELL CAUSED BY LIVESTOCK AND POULTRY FARMS K |
| 700 | 71 | 2780 | AIR-WASHER | AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS KEYWORDS ODOR CONFINEMENT-PENS F |
| 400 | 74 | 2177 | ALABAMA | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
| 200 | 75 | 2698 | ALAMASK-151A | CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO REDUCE MALODORS KEYWORDS CHEMICAL-TREATME |
| 200 | 75 | 2698 | ALAMASK-518 | CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO REDUCE MALODORS KEYWORDS CHEMICAL-TREATME |
| 300 | 73 | 2243 | ALBERTA | CONFINEMENT LIVESTOCK FACILITIES WASTE MANAGEMENT CODE OF PRACTICE KEYWORDS CANADA AL |
| 400 | 67 | 2620 | ALBERTA | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 100 | 72 | 2800 | ALCOHOLS | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 700 | 71 | 1665 | ALGAE | MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM WASTE LAGOON KEYWORDS FAR |
| 200 | 69 | 1700 | ALGAE | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 300 | 71 | 1866 | ALGAE | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 300 | 71 | 1903 | ALGAE | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 400 | 72 | 1940 | ALGAE | WARM WATER STUDY KEYWORDS REGULATION FEEDS ALGAE FEEDLOTS GENERATING-PLANT WARM-WATER |
| 100 | 72 | 2112 | ALGAE | SHORT CUTS FROM MUCK TO MEALS KEYWORDS FEEDS RECLAMATION EFFLUENT FISH ALGAE MOLLUSK |
| 200 | 70 | 2397 | ALGAE | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 200 | 74 | 2459 | ALGAE | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 700 | 73 | 2532 | ALGAE | ALGAL GROWTH POTENTIAL OF SWINE WASTE KEYWORDS ALGAE GROWTH-RATES NUTRIENTS CHEMICAL- |
| 200 | 75 | 2631 | ALGAE | SWINE WASTE NUTRIENT RECOVERY SYSTEM BASED ON THE USE OF THERMAL DISCHARGES KEYWORDS |
| 200 | 75 | 2683 | ALGAE | OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR L AND EUGLENA SP KEYWORDS |
| 400 | 75 | 2814 | ALGAE | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 100 | 73 | 2249 | ALIPHATIC-AMINES | IDENTIFICATION OF ALIPHATIC AMINES VOLATILIZED FROM CATTLE FEEDYARD KEYWORDS FEEDLOT |
| 300 | 73 | 1896 | ALKALIE | RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES KEYWORDS RUMINAN |
| 600 | 73 | 1813 | ALKALINITY | EXPERIENCE WITH A SPRAY RUNOFF SYSTEM FOR TREATING BEEF CATTLE FEEDLOT RUNOFF KEYWORDS |
| 100 | 73 | 1905 | ALKALINITY | AEROBIC TREATMENT OF PIGGERY WASTE KEYWORDS AEROBIC-TREATMENT SWINE EFFLUENTS SUSPEND |
| 300 | 73 | 2043 | ALKALI | GUIDELINES FOR LAND DISPOSAL OF FEEDLOT LAGOON WATER KEYWORDS FEEDLOTS LAGOONS KANSAS |
| 100 | 71 | 1796 | ALTERNATIVES | SLUDGE DISPOSAL-A CASE OF LIMITED ALTERNATIVES KEYWORDS SLUDGE-DISPOSAL ALTERNATIVES F |
| 100 | 74 | 2525 | ALUM | PHOSPHATE REMOVAL FROM DUCK FARM WASTES KEYWORDS WASTE-WATER-POLLUTION WASTE-WATER-TR |
| 400 | 73 | 1957 | AMINES | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 100 | 72 | 2239 | AMINES | FATE OF NITROGEN UNDER INTENSIVE ANIMAL FEEDING KEYWORDS NITROGEN-COMPOUNDS FEEDLOTS D |
| 700 | 71 | 2308 | AMINES | NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA |
| 100 | 71 | 2424 | AMINES | VOLATILIZATION OF NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS KEYWORDS FEEDL |
| 100 | 75 | 2543 | AMINES | METHODS FOR MEASURING SHORT CHAIN FATTY ACIDS AND AMMONIA FROM ANIMAL WASTES KEYWORDS |
| 400 | 74 | 1771 | AMINO-ACIDS | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 200 | 74 | 2021 | AMINO-ACIDS | NUTRITIVE VALUE OF AMINO ACID PRODUCED IN AN OXIDATION DITCH FROM WASTE KEYWORDS PROT |
| 300 | 73 | 2053 | AMINO-ACIDS | SWINE WASTE AS NUTRIENT SOURCE FOR FINISHING PIGS KEYWORDS FEEDS NUTRIENTS PERFORMANC |
| 600 | 72 | 2074 | AMINO-ACIDS | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE |
| 400 | 72 | 2309 | AMINO-ACIDS | PROCESSED POULTRY MANURE AS A FEEDSTUFF KEYWORDS POULTRY PERFORMANCE PHOSPHORUS AMIN |
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| 100 | 73 | 2431 | AMINO-ACIDS | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 100 | 60 | 2518 | AMINO-ACIDS | DISTRIBUTION OF THE MAJOR NITROGENOUS COMPOUNDS AND AMINO ACIDS IN CHICKEN URINE KEYWO |
| 200 | 75 | 2948 | AMINO-ACIDS | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUT |
| 100 | 69 | 1659 | AMMONIA | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 700 | 71 | 1668 | AMMONIA | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 700 | 71 | 1689 | AMMONIA | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 700 | 70 | 1736 | AMMONIA | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 300 | | 1774 | AMMONIA | EFFECT OF ATMOSPHERIC AMMONIA AND THE STRESS OF INFECTIOUS BRONCHITIS VACCINATION ON L |
| 200 | 74 | 1777 | AMMONIA | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 100 | 73 | 1832 | AMMONIA | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 300 | 73 | 1851 | AMMONIA | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 400 | 73 | 1854 | AMMONIA | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES KEYWORDS AMMONIA LITTER BROILERS V |
| 600 | 72 | 1875 | AMMONIA | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 300 | 73 | 1881 | AMMONIA | A RECIRCULATING WASTE SYSTEM FOR SWINE UNITS KEYWORDS SWINE WASTE-TREATMENT OXIDATION |
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| 400 | 73 | 1957 | AMMONIA | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 100 | 74 | 2045 | AMMONIA | CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN STORED DAIRY MANURE KEYWOR |
| 400 | 74 | 2048 | AMMONIA | CONVENTIONAL CONFINEMENT OF FLUME KEYWORDS CONFINEMENT-PENS FLUMES COSTS PERFORMANCE |
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| 400 | 71 | 2271 | AMMONIA | POULTRY HOUSES THAT MAKE GOOD NEIGHBORS KEYWORDS ODOR DUSTS VENTILATION AMMONIA GASES |
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| 300 | 69 | 2099 | AMMONIA-REMOVAL | AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHAN |
| 300 | 73 | 1873 | AMMONIA-STRIPPING | DEVELOPMENT AND DEMONSTRATION OF NUTRIENT REMOVAL FROM ANIMAL WASTES KEYWORDS NITROGE |
| 100 | 75 | 2813 | AMMONIFICATION | CORN RESPONSE AND SOIL NITROGEN TRANSFORMATIONS FOLLOWING VARIED APPLICATION OF POULTRY |
| 100 | 73 | 1653 | AMMONIUM | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 74 | 1655 | AMMONIUM | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 600 | 73 | 2245 | AMMONIUM | GROUNDWATER QUALITY BENEATH A MANURE DISPOSAL AREA KEYWORDS WASTE-DISPOSAL NUTRIENTS N |
| 200 | 75 | 2659 | AMMONIUM-PHOSPHATE | SEPARATING NUTRIENTS TO ENHANCE SWINE WASTE DIGESTION KEYWORDS ANAEROBIC-DIGESTION MET |
| 300 | 68 | 1625 | ANAEROBIC-BACTERIA | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 100 | 72 | 1788 | ANAEROBIC-BACTERIA | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 400 | 74 | 1909 | ANAEROBIC-BACTERIA | COOKING WITH COW POWER KEYWORDS METHANE ANAEROBIC-BACTERIA CATTLE FERTILIZERS RECYCLI |
| 300 | 61 | 2326 | ANAEROBIC-BACTERIA | INDOOR LAGOON FOR POULTRY MANURE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL WASTE-TREAT |
| 700 | 67 | 1651 | ANAEROBIC-CONDITIO | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 200 | 64 | 1695 | ANAEROBIC-CONDITIO | IDENTIFICATION AND CONTROL OF ODORS FROM ANIMAL WASTES KEYWORDS ODOR-CONTROL ANAEROBIC |
| 700 | 69 | 1708 | ANAEROBIC-CONDITIO | SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT KEYWORDS SOILS P |
| 600 | 72 | 1709 | ANAEROBIC-CONDITIO | NUTRIENT CHANGES IN POULTRY EXCRETA FERMENTED WITH RUMEN BACTERIA KEYWORDS NUTRIENTS |
| 600 | 74 | 1712 | ANAEROBIC-CONDITIO | MOVEMENT OF MANURIAL NITROGEN IN COOL HUMID CLIMATES KEYWORDS MODEL-STUDIES NITROGEN M |
| 600 | 71 | 1730 | ANAEROBIC-CONDITIO | SOIL CONSERVATION SERVICE PROGRAM IN ANIMAL WASTE MANAGEMENT KEYWORDS SOIL-CONSERVATI |
| 700 | 70 | 1736 | ANAEROBIC-CONDITIO | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 200 | 69 | 1760 | ANAEROBIC-CONDITIO | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 700 | 71 | 1762 | ANAEROBIC-CONDITIO | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |
| 700 | 70 | 1779 | ANAEROBIC-CONDITIO | THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS KEYWORDS NITROGEN FEEDLOTS SOILS CAT |
| 100 | 72 | 1798 | ANAEROBIC-CONDITIO | EVALUATION OF ANAEROBIC LAGOON TREATING SWINE WASTES KEYWORDS LAGOONS ANAEROBIC-CONDI |
| 200 | 70 | 1805 | ANAEROBIC-CONDITIO | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 400 | 73 | 1817 | ANAEROBIC-CONDITIO | FLUSH SYSTEM CUTS CONFINEMENT COSTS KEYWORDS CONFINEMENT-PENS CATTLE COSTS FLUSH-SYST |
| 600 | 73 | 1844 | ANAEROBIC-CONDITIO | FORMS OF NITROGEN IN ANIMAL WASTE KEYWORDS NITROGEN-COMPOUNDS WASTE-TREATMENT WASTE-S |
| 700 | 71 | 1864 | ANAEROBIC-CONDITIO | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 400 | 72 | 1939 | ANAEROBIC-CONDITIO | WASTE CONVERSION UNIT DEVELOPED KEYWORDS FEEDS METHANE FERMENTATION ANAEROBIC-CONDITI |
| 300 | 74 | 2100 | ANAEROBIC-CONDITIO | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 500 | 74 | 2132 | ANAEROBIC-CONDITIO | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
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| 300 | 72 | 2313 | ANAEROBIC-CONDITIO | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 75 | 2365 | ANAEROBIC-CONDITIO | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS EF |
| 300 | 74 | 2388 | ANAEROBIC-CONDITIO | SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE KEYWORD |
| 200 | 73 | 2440 | ANAEROBIC-CONDITIO | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
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| 200 | 75 | 2617 | ANAEROBIC-CONDITIO | WASTE MANAGEMENT AT HALL BROTHERS DAIRY KEYWORDS DAIRY-INDUSTRY CONFINEMENT-PENS SEPAR |
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| 200 | 75 | 2675 | ANAEROBIC-CONDITIO | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 200 | 75 | 2738 | ANAEROBIC-CONDITIO | TRENDS AND VARIATIONS IN AN ANAEROBIC LAGOON WITH RECYCLING KEYWORDS LAGOONS ANAEROBI |
| 200 | 75 | 2754 | ANAEROBIC-CONDITIO | POLLUTION ABATEMENT OF POULTRY MANURE BY MAXI-MIXING METHOD KEYWORDS POULTRY COSTS WAS |
| 100 | 70 | 2786 | ANAEROBIC-CONDITIO | TREATMENT AND DISPOSAL OF ANIMAL WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL ANIMA |
| 100 | 71 | 2807 | ANAEROBIC-CONDITIO | INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIAL |
| 100 | 74 | 2802 | ANAEROBIC-DIGESTER | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 300 | 74 | 1627 | ANAEROBIC-DIGESTIO | ANAEROBIC AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES KEYWORDS AEROBIC-TREATMENT A |
| 200 | 68 | 1642 | ANAEROBIC-DIGESTIO | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 200 | 64 | 1692 | ANAEROBIC-DIGESTIO | WASTE DISPOSAL CONCEPTS KEYWORDS WASTE-DISPOSAL EXCRETA POULTRY LAGOONS ANAEROBIC-DIG |
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| 400 | 74 | 1808 | ANAEROBIC-DIGESTIO | MONFORT FUELS FEEDLOT AND PLANT WITH MANURE KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA |
| 300 | 71 | 1866 | ANAEROBIC-DIGESTIO | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 200 | 74 | 1867 | ANAEROBIC-DIGESTIO | SURMOUNTING THE POULTRY WASTE PROBLEM KEYWORDS POULTRY EXCRETA WASTE-MANAGEMENT ANAER |
| 300 | 74 | 1959 | ANAEROBIC-DIGESTIO | ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS RECYCLING ANIMAL- |
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| 700 | 63 | 2233 | ANAEROBIC-DIGESTIO | CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE KEYWORDS FARM-WASTES HOGS ANAE |
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| 400 | 74 | 2336 | ANAEROBIC-DIGESTIO | MUNICIPAL SLUDGE IN SWINE MANURE HELPS CONTROL ODORS KEYWORDS WASTE-TREATMENT ODOR-CON |
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| 300 | 71 | 2387 | ANAEROBIC-DIGESTIO | BIOLOGICAL TREATMENT OF BEEF ANIMAL WASTES KEYWORDS ANAEROBIC-DIGESTION WASTE-TREATMEN |
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| 100 | 71 | 1910 | BIOCHEMICAL-OXYGEN | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 200 | 74 | 2033 | BIOCHEMICAL-OXYGEN | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 300 | 73 | 2039 | BIOCHEMICAL-OXYGEN | DEMONSTRATION OF WASTE DISPOSAL SYSTEM KEYWORDS CATTLE HOGS ANIMAL-WASTES SHEEP CHEMI |
| 600 | 72 | 2074 | BIOCHEMICAL-OXYGEN | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE |
| 300 | 72 | 2105 | BIOCHEMICAL-OXYGEN | LAGOONS FOR ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS DESIGN LOADING LAGO |
| 100 | 72 | 2110 | BIOCHEMICAL-OXYGEN | TOXICITY OF SEAWATER TO COLIFORM BACTERIA KEYWORDS TOXICITY SEAWATER COLIFORMS BACTER |
| 200 | 63 | 2155 | BIOCHEMICAL-OXYGEN | FOWL FECAL FACTS KEYWORDS POULTRY PHYSICAL-PROPERTIES CHEMICAL-PROPERTIES BIOCHEMICAL |
| 700 | 63 | 2233 | BIOCHEMICAL-OXYGEN | CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE KEYWORDS FARM-WASTES HOGS ANAE |
| 700 | 67 | 2234 | BIOCHEMICAL-OXYGEN | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 400 | 72 | 2290 | BIOCHEMICAL-OXYGEN | NEW WASTE TREATMENT SYSTEM IS USED FOR HOGS KEYWORDS WASTE-TREATMENT SEPARATION-TECHNI |
| 300 | 72 | 2292 | BIOCHEMICAL-OXYGEN | MANURE HOLDING PONDS FOUND SELFSEALING KEYWORDS WASTE-STORAGE WATER-POLLUTION POULTRY |
| 700 | 71 | 2307 | BIOCHEMICAL-OXYGEN | FECAL COLIFORM POLLUTION IN AN AGRICULTURAL ENVIRONMENT KEYWORDS WATER-POLLUTION AGRIC |
| 700 | 68 | 2318 | BIOCHEMICAL-OXYGEN | THE EFFECTS OF LOADING RATES ON THE DESIGN AND OPERATION OF ANAEROBIC SWINE LAGOONS KE |
| 700 | 67 | 2363 | BIOCHEMICAL-OXYGEN | ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S |
| 100 | 74 | 2404 | BIOCHEMICAL-OXYGEN | CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH KEYWORDS |
| 100 | 72 | 2412 | BIOCHEMICAL-OXYGEN | A STUDY OF A FULL SCALE SWINE WASTE DISPOSAL SYSTEM KEYWORDS WASTE-TREATMENT BIOCHEMIC |
| 300 | 71 | 2451 | BIOCHEMICAL-OXYGEN | LIVESTOCK FEEDLOTS ARE POLLUTION SOURCE KEYWORDS FEEDLOTS WATER-POLLUTION MINNESOTA BI |
| 100 | 74 | 2502 | BIOCHEMICAL-OXYGEN | A SURVEY OF EFFECTS OF ANIMAL WASTES ON STREAM POLLUTION FROM SELECTED DAIRY FARMS KEY |
| 200 | 75 | 2720 | BIOCHEMICAL-OXYGEN | EVALUATION OF SOLIDS SEPARATION DEVICES KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN |
| 700 | 64 | 2768 | BIOCHEMICAL-OXYGEN | CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT |
| 600 | 72 | 2106 | BIOCHEMICAL-PROPER | EVALUATION OF METHODS FOR THE ANALYSIS OF PHYSICAL CHEMICAL AND BIOCHEMICAL PROPERTIES |
| 100 | 71 | 2570 | BIOCONCENTRATION | BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN KEYWORDS MICROORGANISMS TOXICITY FEEDLOT |
| 200 | 74 | 1868 | BIOCONVERSION | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 100 | 72 | 2314 | BIOCONVERSION | FUEL FROM WASTES-A MINOR ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 100 | 73 | 1801 | BIODEGRADATION | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE K |
| 600 | 73 | 1815 | BIODEGRADATION | ELECTRICALLY MANAGING WASTE FROM CAGED LAYERS KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL |
| 100 | 71 | 1910 | BIODEGRADATION | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 100 | 74 | 1912 | BIODEGRADATION | AERATION OF POULTRY WASTES FOR ODOR AND NITROGEN CONTROL KEYWORDS POULTRY AERATION NIT |
| 700 | 68 | 2318 | BIODEGRADATION | THE EFFECTS OF LOADING RATES ON THE DESIGN AND OPERATION OF ANAEROBIC SWINE LAGOONS KE |
| 100 | 73 | 2325 | BIODEGRADATION | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICICAL ACTIVITY AGAINST HOUSE |
| 300 | 74 | 2388 | BIODEGRADATION | SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE KEYWORD |
| 100 | 71 | 2402 | BIODEGRADATION | BIODEGRADATION OF PIG WASTE BREAKDOWN OF SOLUBLE NITROGEN COMPOUNDS AND THE EFFECT OF C |
| 200 | 75 | 2682 | BIODEGRADATION | INFLUENCE OF ANTIBIOTICS AND GROWTH PROMOTING FEED ADDITIVES ON THE MANURING EFFECT OF |
| 200 | 74 | 1868 | BIOELECTRICITY | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 200 | 74 | 1868 | BIOFERTILIZER | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 300 | 74 | 2323 | BIOGASIFICATION | OKLAHOMA MANURE FOR MIDWEST METHANE KEYWORDS METHANE FUELS OKLAHOMA RECYCLING CATTLE |
| 300 | 68 | 2220 | BIOINDICATORS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 100 | 74 | 2585 | BIOLOGICAL-CONTAMI | POLLUTION EFFECTS ON SURFACE AND GROUND WATERS KEYWORDS WATER-POLLUTION-SOURCES NUTRIE |
| 400 | 69 | 1924 | BIOLOGICAL-DIGESTI | BIOLOGICAL DIGESTION OF MANURE BY DIPTERA KEYWORDS MANURE DIPTERA BIOLOGICAL-DIGESTIO |
| 300 | 74 | 1782 | BIOLOGICAL-ORGANIC | POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS KEYWORDS FISH-FARMING |
| 300 | 74 | 2044 | BIOLOGICAL-OXYGEN- | LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS KEYWORDS LIQ |
| 500 | 74 | 2132 | BIOLOGICAL-PROCESS | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
| 200 | 74 | 2019 | BIOLOGICAL-PROPERT | THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE |
| 200 | 63 | 2156 | BIOLOGICAL-PROPERT | MANURE DISPOSAL LAGOONS KEYWORDS LAGOONS WASTE-TREATMENT WASTE-DISPOSAL CHEMICAL-PRO |
| 700 | 72 | 2316 | BIOLOGICAL-PROPERT | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 200 | 74 | 2470 | BIOLOGICAL-PROPERT | WASTE HANDLING AND LAGOON MANAGEMENT KEYWORDS LAGOONS FEEDLOTS DESIGN CHEMICAL-PROPER |
| 200 | 75 | 2675 | BIOLOGICAL-PROPERT | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 700 | 64 | 2768 | BIOLOGICAL-PROPERT | CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT |
| 600 | 72 | 1752 | BIOLOGICAL-REDUCTI | ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE KEYWORDS AERATION LARVAE F |
| 600 | 73 | 1754 | BIOLOGICAL-TREATME | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING KEYWORDS FEEDLOTS AGRICULTUR |
| 700 | 73 | 2061 | BIOLOGICAL-TREATME | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF KEYWORDS BIOLOGICAL-TREATMENT AGRICULTURAL-RUN |
| 100 | 69 | 2380 | BIOLOGICAL-TREATME | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS KEYWORDS WAST |
| 100 | 74 | 24[illegible] | BIOLOGICAL-TREATME | TECHNICAL ASPECTS OF LIQUID COMPOSTING KEYWORDS DAIRY-INDUSTRY ODOR BIOLOGICAL-TREATM |
| 700 | 74 | [illegible] | BIOLOGICAL-TREATME | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 600 | 75 | [illegible] | BIOLOGICAL-TREATME | NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT KEYWORDS TECHNOLOGY NUTRIENTS NITROG |
| 200 | 75 | 2[illegible]46 | BIOLOGICAL-TREATME | ODOR CONTROL OF LIQUID DAIRY AND SWINE MANURE USING CHEMICAL AND BIOLOGICAL TREATMENTS |
| 200 | 75 | 2717 | BIOLOGICAL-TREATME | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 200 | 75 | 2735 | BIOLOGICAL-TREATME | AN EVALUATION OF AERATION SYSTEMS FOR POULTRY WASTES UNDER COMMERCIAL CONDITIONS KEYWO |
| 600 | 71 | 1716 | BIOLOGY | BIOLOGY OF WASTE MANAGEMENT KEYWORDS BIOLOGY WASTE-MANAGEMENT MICROORGANISMS METABOLI |
| 100 | 71 | 2570 | BIOTRANSFER | BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN KEYWORDS MICROORGANISMS TOXICITY FEEDLOT |
| 300 | 74 | 2100 | BIO-GAS | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 400 | 74 | 2493 | BIO-GAS-DIGESTER | FUEL FOR THOUGHT-IS STOCKPILED ENERGY GOING TO WASTE KEYWORDS METHANE FERTILIZERS FEED |
| 400 | 73 | 2364 | BIO-GAS-PLANTGLOCK | BIO GAS DISPOSAL SYSTEM NOT ON KEYWORDS METHANE COSTS ANAEROBIC-DIGESTION EFFLUENT NE |
| 100 | 72 | 2500 | BIO-GAS-PLANT | THE BIO GAS PLANT-GENERATING METHANE FROM ORGANIC WASTES KEYWORDS RECYCLING ORGANIC-WA |

# KEYWORD INDEX

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|---|---|---|---|---|
| 700 | 71 | 1766 | BLACK-GLOBE | WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE KEY |
| 200 | 74 | 1989 | BLOODMEAL | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS PER |
| 300 | 74 | 2173 | BLOODMEAL | PAUNCH CONTENT BLOODMEAL MIXTURE AS PROTEIN SUPPLEMENT IN FEEDLOT RATIONS KEYWORDS FE |
| 400 | 75 | 2499 | BLOOD | PAUNCH FEEDING NOW PROFITABLE KEYWORDS ECONOMICS CATTLE REFEEDING PAUNCH-MANURE BLOOD |
| 100 | 73 | 2226 | BLUEGILL-SUNFISH | INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH LEPOMI |
| 400 | 73 | 1946 | BOARD | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 400 | 74 | 2203 | BOWER-VS-HOG-BUILD | NUISANCE LAWSUITS-NEIGHBOR VS NEIGHBOR KEYWORDS LEGAL-ASPECTS WASTE-TREATMENT WASTE-D |
| 400 | 74 | 1816 | BREEDING | THREE DAIRYMEN REPORT HOW SLATTED FLOORS HAVE WORKED FOR THEM KEYWORDS DAIRY-INDUSTRY |
| 400 | 71 | 2083 | BREEDING | DO MANURE STACKS ADD TO FLY CONTROL PROBLEMS KEYWORDS BREEDING DAIRY-INDUSTRY FLY-CONT |
| 600 | 72 | 2122 | BREEDING | CONFINEMENT HOUSING SYSTEMS FOR SOWS KEYWORDS CONFINEMENT-PENS BREEDING WASTE-DISPOSA |
| 100 | 72 | 2359 | BRESSLER-SYSTEM | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR |
| 100 | 73 | 2051 | BROAD-BASIN-TERRAC | BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS KEYWORDS TERRACES FEEDLOTS DESIGN MA |
| 400 | 72 | 2320 | BROAD-BASIN-TERRAC | THINK OF MANURE AS A RESOURCE-NOT A WASTE KEYWORDS WATER-POLLUTION AGRICULTURAL-RUNOF |
| 100 | 73 | 2447 | BROAD-BASIN-TERRAC | SOIL WATER NITRATE BENEATH A BROAD BASIN TERRACED FEEDLOT KEYWORDS SOIL-WATER NITRATES |
| 300 | 73 | 1620 | BROILERS | PROTOTYPE OF A BROILER CAGE SYSTEM KEYWORDS BROILERS PERFORMANCE CAGE-SYSTEM CROSS-AU |
| 400 | 74 | 1771 | BROILERS | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 200 | 69 | 1824 | BROILERS | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
| 400 | 73 | 1854 | BROILERS | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES KEYWORDS AMMONIA LITTER BROILERS V |
| 100 | 71 | 1902 | BROILERS | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 400 | 73 | 2266 | BROILERS | VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY KEYWORDS FEEDS POULTRY ENERGY |
| 400 | 67 | 2420 | BROILERS | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 100 | 75 | 2427 | BROILERS | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 100 | 73 | 2431 | BROILERS | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 300 | 74 | 2527 | BROILERS | FERMENTATION OF ENSILED BROILER LITTER KEYWORDS FERMENTATION LITTER PATHOGENS DRYING |
| 100 | 71 | 2787 | BROILERS | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 400 | 72 | 2036 | BROILER-BREEDERS | PROFIT TOO IN MANURE FROM PLASTIC PENS KEYWORDS FARM-WASTES POULTRY ECONOMICS WASTE-T |
| 100 | 74 | 1950 | BROILER-LITTER | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORD |
| 100 | 75 | 2244 | BROILER-LITTER | EFFECT OF PROCESSING METHOD ON PASTURIZATION AND NITROGEN COMPONENTS OF BROILER LITTER |
| 400 | 75 | 2349 | BROILER-LITTER | RECYCLING POULTRY LITTER AS SILAGE KEYWORDS RECYCLING SILAGE CATTLE WEIGHT TASTE POUL |
| 300 | 65 | 2377 | BROILER-LITTER | BROILER LITTER AS A FERTILIZER KEYWORDS FERTILIZERS NUTRIENTS BROILER-LITTER LAND-DIS |
| 200 | 70 | 2397 | BROILER-LITTER | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 200 | 74 | 2461 | BROILER-LITTER | BRIOLER LITTER FOR CROP PRODUCTION KEYWORDS POULTRY FERTILIZERS COSTS CROP-PRODUCTION |
| 100 | 75 | 2544 | BROILER-LITTER | LAND DISPOSAL OF BROILER LITTER-CHANGES IN SOIL POTASSIUM CALCIUM AND MAGNESIUM KEYWOR |
| 300 | 74 | 2177 | BROILER-WASTE | RECYCLING POULTRY WASTE AS FEED WILL IT PAY KEYWORDS RECYCLING FEEDS ECONOMICS INCINER |
| 300 | 74 | 1783 | BROMEGRASS | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE P |
| 400 | 72 | 2554 | BRUCELLOSIS | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 600 | 74 | 1757 | BUDGETING | AN ANALYSIS OF THE WATER BUDGET AND WASTE TREATMENT AT A MODERN DAIRY KEYWORDS WATER |
| 600 | 72 | 1753 | BUFFALO-LAKE | BUFFALO LAKE RECREATIONAL WATER QUALITY A STUDY IN BACTERIOLOGICAL DATA INTERPRETATION |
| 100 | 69 | 1659 | BUFFERS | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 300 | 73 | 1617 | BUFFER-ZONE | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 200 | 72 | 2279 | BUILDING-MATERIALS | NUTRIENT RECYCLING-MODERN ENERGY MANAGEMENT KEYWORDS NUTRIENTS RECYCLING ENERGY INCINE |
| 300 | 72 | 2386 | BUILDING-MATERIALS | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
| 400 | 71 | 2454 | BUILDING-MATERIALS | WHY WASTE ANIMAL WASTES KEYWORDS WASTE-DISPOSAL RECYCLING LAGOONS ANIMAL-WASTES ECOLI |
| 200 | 75 | 2657 | BUILDING-MATERIALS | PRODUCT APPLICATIONS OF TREATED LIVESTOCK WASTE KEYWORDS RECYCLING PIGMENTS FEEDLOTS C |
| 400 | 72 | 2805 | BUILDING-MATERIALS | FEEDLOT WASTE USABLE KEYWORDS FEEDLOTS RECYCLING FEEDS PERFORMANCE FRACTIONATION BUIL |
| 200 | 69 | 1980 | BUILT-UP-LITTER | THE REUSE OF OLD LITTER KEYWORDS LITTER POULTRY REUSE BUILT-UP-LITTER MAREKS-DISEASE |
| 200 | 75 | 2727 | BULKING-MATERIAL | COMPOSTING SWINE WASTE KEYWORDS YIELDS COMPOSTING SWINE WINDROW-TECHNIQUE BULKING-MAT |
| 100 | 74 | 1951 | BULK-DENSITY | EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE KEYWORDS MOISTURE-CO |
| 100 | 74 | 2252 | BULK-DENSITY | FEEDLOT WASTE EFFECTS ON SOIL CONDITIONS AND WATER EVAPORATION KEYWORDS FEEDLOTS EFFE |
| 300 | 72 | 2063 | BURNING | COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE KEYWORDS BURNING |
| 300 | 74 | 2044 | BY-PRODUCTS | LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS KEYWORDS LIQ |
| 400 | 75 | 2501 | BY-PRODUCTS | MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS KEYWORDS RECYCLING BY-PRODUCTS FEED |
| 600 | 74 | 1847 | CABLE-DRIVEN-SCRAP | CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION KEYWORDS LIQU |
| 300 | 72 | 1647 | CAGED-LAYERS-HOUSE | HOUSE FLY CONTROL IN CAGED LAYER HOUSES KEYWORDS LARVAE FLY-CONTROL CAGED-LAYERS-HOUS |
| 200 | 74 | 2004 | CAGED-LAYER-PRODUC | A COMPLETE SYSTEM FOR COLLECTING HANDLING AIR DRYING AND MACHINE DEHYDRATION OF POULTRY |
| 100 | 69 | 2380 | CAGED-LAYING-HENS | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS KEYWORDS WAST |
| 100 | 70 | 1853 | CAGED-POULTRY-HOUS | INTEGRATED FLY CONTROL PROGRAM FOR CAGED POULTRY HOUSES KEYWORDS FLY-CONTROL CAGED-POU |
| 200 | 75 | 2641 | CAGE-LAYER-MANURE | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 400 | 68 | 2378 | CAGE-MANURE | MANAGEMENT AND UTILIZATION OF POULTRY WASTES KEYWORDS LITTER WASTE-TREATMENT WASTE-DIS |
| 700 | 65 | 1666 | CAGE-ROTOR | PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH KEYWORDS OXIDATION-DITCH PERFORMANCE |
| 100 | 74 | 2223 | CAGE-ROTOR-SYSTEM | COMPARISON OF THE CONVENTIONAL CAGE ROTOR AND JET-AERO-MIX SYSTEMS IN OXIDATION DITCH |
| 300 | 73 | 1620 | CAGE-SYSTEM | PROTOTYPE OF A BROILER CAGE SYSTEM KEYWORDS BROILERS PERFORMANCE CAGE-SYSTEM CROSS-AU |
| 300 | 72 | 2268 | CAGE-SYSTEM | FLY CONTROL ON POULTRY FARMS KEYWORDS INSECTICIDES FLY-CONTROL SANITATION OPEN-FLOOR- |
| 300 | 72 | 1628 | CAISSONS | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 400 | 72 | 2211 | CAISSONS | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING BA |
| 400 | 74 | 1771 | CALCIUM | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 300 | 74 | 2217 | CALCIUM | COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING |
| 100 | 74 | 2236 | CALCIUM | USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL |
| 100 | 73 | 2277 | CALCIUM | LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A |
| 300 | 72 | 2371 | CALCIUM | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PHOS |
| 100 | 75 | 2544 | CALCIUM | LAND DISPOSAL OF BROILER LITTER-CHANGES IN SOIL POTASSIUM CALCIUM AND MAGNESIUM KEYWOR |
| 200 | 73 | 2548 | CALCIUM | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUT |
| 200 | 75 | 2646 | CALCIUM | MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE |
| 100 | 72 | 2764 | CALCIUM | THE REMOVAL OF ANIMAL EXCREMENTS FROM MASS-STOCK FARMS AS A WATER ECONOMY PROBLEM KEYW |
| 200 | 73 | 1648 | CALCIUM-BENTONITE | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 400 | 74 | 1827 | CALIFORNIA | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AER |
| 200 | 73 | 1895 | CALIFORNIA | AGRICULTURAL WASTES AND GROUND WATER QUALITY KEYWORDS WATER-POLLUTION-SOURCES FARM-WAS |
| 400 | 73 | 1957 | CALIFORNIA | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 100 | 72 | 2187 | CALIFORNIA | NITRATES IN SOIL AND GROUND WATER BENEATH IRRIGATED AND FERTILIZED CROPS KEYWORDS NIT |
| 300 | 71 | 2286 | CALIFORNIA | IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE |
| 300 | 72 | 2292 | CALIFORNIA | MANURE HOLDING PONDS FOUND SELFSEALING KEYWORDS WASTE-STORAGE WATER-POLLUTION POULTRY |
| 400 | 75 | 2345 | CALIFORNIA | RECYCLING NUTRIENTS FOR LIVESTOCK KEYWORDS RECYCLING POULTRY REGULATION CALIFORNIA MI |
| [illegible]00 | 75 | 2411 | CALIFORNIA | SURFACE RUNOFF IN DAIRIES KEYWORDS AGRICULTURAL-RUNOFF DAIRY-INDUSTRY WATER-POLLUTION |
| 400 | 74 | 2418 | CALIFORNIA | CHINO VALLEY SHAKER KEYWORDS DAIRY-INDUSTRY CALIFORNIA FERTILIZERS ODOR SPRINKLER-IRR |
| 100 | 75 | 2422 | CALIFORNIA | WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS |
| 200 | 74 | 2460 | CALIFORNIA | MARKETING CONVERTED MANURE KEYWORDS MARKETING FERTILIZERS FEEDS COSTS CALIFORNIA IOWA |
| 300 | 75 | 2545 | CALIFORNIA | INTEGRATED FLY CONTROL ON POULTRY RANCHES KEYWORDS PREDATORS SCAVENGERS POULTRY CALIFO |
| 400 | 75 | 2547 | CALIFORNIA | ON THE HORNS OF THE DAIRY WASTE DILEMMA KEYWORDS DAIRY-INDUSTRY CALIFORNIA REGULATION |
| 200 | 75 | 2623 | CALIFORNIA | A PLANNING STUDY ON DAIRY WASTES MANAGEMENT KEYWORDS DAIRY-INDUSTRY CALIFORNIA WATER-P |
| 200 | 75 | 2728 | CALIFORNIA | LIQUID COMPOSTING OF DAIRY MANURE KEYWORDS LIQUID-WASTES DAIRY-INDUSTRY CALIFORNIA E |
| 400 | 74 | 1885 | CALIFORNIA-DEPARTM | CALIFORNIA ISSUES DPW REGULATIONS KEYWORDS REGULATION DRIED-ANIMAL-WASTES LICENSE PRO |
| 100 | 74 | 2775 | CALORIFIC-VALUE | EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO |
| 700 | 73 | 2583 | CALORIMETRY | CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK |
| 400 | 71 | 1898 | CANADA | ANIMAL WASTE DISPOSAL KEYWORDS ANIMAL-WASTES WASTE-DISPOSAL CANADA AEROBIC-TREATMENT |
| 100 | 72 | 2186 | CANADA | HANDLING MILKING PARLOR WASTE KEYWORDS DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM |
| 300 | 73 | 2243 | CANADA | CONFINEMENT LIVESTOCK FACILITIES WASTE MANAGEMENT CODE OF PRACTICE KEYWORDS CANADA AL |
| 400 | 72 | 2376 | CANADA | HOW TO DISPOSE OF MANURE AND STAY OUT OF COURT KEYWORDS WASTE-MANAGEMENT LEGAL-ASPECTS |
| 400 | 67 | 2420 | CANADA | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 200 | 75 | 2655 | CANADA | START UP OF PILOT SCALE SWINE MANURE DIGESTERS FOR METHANE KEYWORDS RESEARCH-AND-DEVE |
| 200 | 75 | 2716 | CANADA | SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST DAIRY |

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| 200 | 75 | 2757 | CANADA | COMPOSITION OF POULTRY MANURE AND EFFECT OF HEAVY APPLICATION ON SOIL CHEMICAL PROPERTI |
| 400 | 73 | 1778 | CAPACITY | MODELS FOR HANDLING SOLID MANURE KEYWORDS SOLID-WASTES MANAGEMENT HANDLING FEEDLOTS H |
| 700 | 68 | 1826 | CARBONATES | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 100 | 73 | 1806 | CARBON | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 300 | 71 | 1865 | CARBON | ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL KEYWORDS POULTRY NITROGEN CARBON A |
| 100 | 71 | 1902 | CARBON | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 100 | 74 | 2131 | CARBON | THE EFFECT OF LARGE APPLICATIONS OF MANURE ON MOVEMENT OF NITRATE AND CARBON IN AN IRRI |
| 700 | 72 | 2448 | CARBON | TRANSFORMATION MOVEMENT AND DISPOSAL OF NITROGEN FROM ANIMAL MANURE WASTES APPLIED TO S |
| 100 | 73 | 2521 | CARBON | SOME EFFECTS OF FERTILIZERS AND FARMYARD MANURE ON THE ORGANIC PHOSPHORUS IN SOILS KEY |
| 700 | 73 | 2532 | CARBON | ALGAL GROWTH POTENTIAL OF SWINE WAST. KEYWORDS ALGAE GROWTH-RATES NUTRIENTS CHEMICAL- |
| 100 | 71 | 2707 | CARBON | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 100 | 72 | 2799 | CARBON | RETORTING FEEDLOT WASTES KEYWORDS FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO |
| 200 | 75 | 2657 | CARBON-CONTENT | PRODUCT APPLICATIONS OF TREATED LIVESTOCK WASTE KEYWORDS RECYCLING PIGMENTS FEEDLOTS C |
| 300 | 71 | 1882 | CARBON-DIOXIDE | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 100 | 71 | 1904 | CARBON-DIOXIDE | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 200 | 73 | 2180 | CARBON-DIOXIDE | HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS KEYWORDS GASES RECYCLING CATTLE AU |
| 700 | 65 | 2188 | CARBON-DIOXIDE | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 100 | 71 | 2200 | CARBON-DIOXIDE | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 | 64 | 2204 | CARBON-DIOXIDE | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 100 | 74 | 2263 | CARBON-DIOXIDE | KINETICS AND ECONOMICS OF ANAEROBIC DIGESTION OF ANIMAL WASTE KEYWORDS KINETICS ECONO |
| 300 | 74 | 2428 | CARBON-DIOXIDE | UNDERFLOOR VENTILATION FOR SLOTTED FLOOR SWINE BUILDINGS KEYWORDS VENTILATION DESIGN C |
| 700 | 72 | 2569 | CARBON-DIOXIDE | RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFF |
| 100 | 63 | 2581 | CARBON-DIOXIDE | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 100 | 72 | 2800 | CARBON-DIOXIDE | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 100 | 74 | 2802 | CARBON-DIOXIDE | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 400 | 74 | 1769 | CARBON-MONOXIDE | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 400 | 73 | 1859 | CARBON-MONOXIDE | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 100 | 72 | 2329 | CARBON-MONOXIDE | CONVERTING ORGANIC WASTES TO OIL KEYWORDS RECYCLING ORGANIC-WASTES OIL CELLULOSE CATT |
| 100 | 72 | 2197 | CARBON-NITROGEN-RA | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
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| 300 | 72 | 2369 | CARCASS-CHARACTERI | COMPARISON OF HOUSING SYSTEMS FOR FEEDLOT CATTLE IN NORTHERN CLIMATES KEYWORDS PERFOR |
| 300 | 72 | 2374 | CARCASS-CHARACTERI | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 400 | 73 | 1822 | CARCASS-IMPROVEMEN | KISSINGERS CASE FOR CONFINEMENT KEYWORDS CONFINEMENT-PENS CATTLE LAGOONS COSTS WASTE- |
| 100 | 73 | 1747 | CATABOLIZED-MANURE | FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS KEYWORDS DIETS POULTRY PROTEINS |
| 100 | 74 | 2047 | CATALYSTS | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 100 | 74 | 2047 | CATALYTIC-HYDROTRE | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 200 | 75 | 2671 | CATCHMENTS | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 600 | 74 | 1756 | CATCHMENT-BASINS | ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN |
| 300 | 74 | 1782 | CATFISHES | POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS KEYWORDS FISH-FARMING |
| 400 | 74 | 1861 | CATFISHES | INCLUSION OF DRIED POULTRY WASTE AS A FEED INGREDIENT IN CATFISH RATIONS KEYWORDS CAT |
| 400 | 75 | 2038 | CATFISHES | POULTRY WASTE FOR CATFISH KEYWORDS CATFISHES DIETS PERFORMANCE PROTEINS POULTRY-WASTE |
| 400 | 75 | 2350 | CATFISHES | CATFISH ON DPW KEYWORDS CATFISHES DIETS PERFORMANCE TASTE COSTS DRIED-POULTRY-WASTE |
| 400 | 74 | 2773 | CATFISHES | THE EDITORS NOTEBOOK-ABOUT DISCHARGE REGULATIONS KEYWORDS CATFISHES RUNOFF PERMITS EN |
| 100 | 75 | 2790 | CATFISHES | TOXICITY OF NITRITE TO CHANNEL CATFISH KEYWORDS CATFISHES NITRITES AMMONIA TOXICITY |
| 300 | 71 | 1903 | CATFISH | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 400 | 74 | 2095 | CATHETERIZATION | URINARY EXCRETION OF QUINALDINE BY CHANNEL CATFISH KEYWORDS URINE CHANNEL-CATFISH QUI |
| 100 | 74 | 2491 | CATIONS | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY C |
| 400 | 73 | 1615 | CATTLE | WILL A CONFINEMENT BARN PAY KEYWORDS CONFINEMENT-PENS ECONOMICS CATTLE COSTS OPEN-LOT |
| 600 | 73 | 1616 | CATTLE | WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS KEYWORDS CATTLE CONFINEMENT-PENS PERFORM |
| 300 | 73 | 1617 | CATTLE | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 400 | 73 | 1618 | CATTLE | THEY BEAT THE HIGH COST OF PROTEIN WITH PLS KEYWORDS COSTS PROTEINS FEEDS POULTRY LIT |
| 300 | 73 | 1622 | CATTLE | THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS KEYWORDS RECYCLING QUALITATIVE-ORG |
| 600 | 73 | 1623 | CATTLE | DEWATERING BOVINE ANIMAL MANURE KEYWORDS DEWATERING CATTLE MANURE SLURRIES IRRIGATION |
| 300 | 74 | 1629 | CATTLE | CONTROL OF DUST FROM CATTLE FEEDLOTS KEYWORDS CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN |
| 400 | 73 | 1632 | CATTLE | FEEDING STEERS DPW KEYWORDS FEEDS POULTRY CATTLE PROTEINS PERFORMANCE DEHYDRATED-POUL |
| 400 | 73 | 1633 | CATTLE | FAST FLUSH SYSTEM KEYWORDS FAST-FLUSH-SYSTEM CATTLE WASTE-TREATMENT WASTE-DISPOSAL FE |
| 400 | 74 | 1636 | CATTLE | MANURE IS FOOD FOR PROTEIN KEYWORDS MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE |
| 400 | 73 | 1638 | CATTLE | EPA PREPARING TO RAILROAD THROUGH NEW POLLUTION RULES COVERING CATTLE FEEDLOTS KEYWORD |
| 200 | 72 | 1645 | CATTLE | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 200 | 73 | 1648 | CATTLE | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 700 | 69 | 1656 | CATTLE | MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF KEYWORDS MATHEMATI |
| 700 | 71 | 1668 | CATTLE | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 100 | 61 | 1669 | CATTLE | TOXICITY TO FLY LARVAE OF THE FECES OF INSECTICIDE FED CATTLE KEYWORDS TOXICITY CATTL |
| 100 | 61 | 1670 | CATTLE | TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE FED CATTLE KEYWORD |
| 400 | 74 | 1676 | CATTLE | ORGANIC FERTILIZER OFFSHOOT OF POLLUTION FREE FEEDLOT KEYWORDS FERTILIZERS POLLUTION |
| 100 | 60 | 1677 | CATTLE | FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES KEYWORDS FEED-ADDIT |
| 600 | 67 | 1683 | CATTLE | PERFORMANCE OF EXPERIMENTAL CLOSE-CONFINEMENT CAGED CATTLE FEEDING SYSTEMS KEYWORDS |
| 600 | 74 | 1684 | CATTLE | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 100 | 73 | 1685 | CATTLE | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 700 | 71 | 1688 | CATTLE | THE AEROBIC DECOMPOSITION OF SOLID BEFF CATTLE FEEDLOT WASTE KEYWORDS AEROBIC-TREATME |
| 700 | 71 | 1689 | CATTLE | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
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| 700 | 72 | 1706 | CATTLE | WATER QUALITY OF STORM RUNOFF FROM A TEXAS BEEF FEEDLOT KEYWORDS WATER-QUALITY STORM-R |
| 600 | 73 | 1711 | CATTLE | ANAEROBIC DIGESTER RESPONSE WITH DAIRY CATTLE MANURE KEYWORDS ANAEROBIC-DIGESTION DAIR |
| 600 | 71 | 1722 | CATTLE | WASTE MANAGEMENT SYSTEMS FOR ROOFED BEEF CONFINEMENT FACILITIES KEYWORDS WASTE-MANAGE |
| 600 | 71 | 1725 | CATTLE | ANIMAL WASTE REUSE KEYWORDS RECYCLING FEEDS POULTRY CATTLE PROTEINS INSECTICIDES COST |
| 600 | 71 | 1726 | CATTLE | EFFECT OF HOUSED CONFINEMENT ON ANIMAL PERFORMANCE KEYWORDS CONFINEMENT-PENS CATTLE P |
| 600 | 71 | 1727 | CATTLE | ECONOMIC CONSIDERATIONS INVOLVED IN SELECTING TYPES OF CONFINEMENT AND WASTE DISPOSAL S |
| 300 | 73 | 1733 | CATTLE | THE ECONOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA KEYWORDS FEEDLOTS CATTLE ZONIN |
| 600 | 74 | 1738 | CATTLE | STORAGE LAGOON VERSUS UNDERFLOOR TANK FOR DAIRY CATTLE MANURE KEYWORDS WASTE-SOTRAGE |
| 300 | 71 | 1739 | CATTLE | CATTLE FEEDLOT POLLUTION STUDY KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL CATTLE FEEDLOT |
| 400 | 73 | 1740 | CATTLE | RUNOFF CONTROL SYSTEMS FOR CONCRETE DAIRY CATTLE YARDS KEYWORDS CATTLE DAIRY-INDUSTRY |
| 400 | 73 | 1741 | CATTLE | CHANGES WE VE MADE IN MANURE HANDLING KEYWORDS MANURE-HANDLING COSTS CATTLE DAIRY-IND |
| 600 | 66 | 1743 | CATTLE | STRUCTURAL ANALYSIS OF FLOOR GRIDS FOR CONFINMENET CATTLE FEEDING SYSTEMS KEYWORDS CO |
| 600 | 74 | 1744 | CATTLE | FIELD PERFORMANCE OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS KEYWORDS CATTLE WAS |
| 300 | 73 | 1745 | CATTLE | GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS KEYWORDS FEEDLOTS MANURE CATTLE |
| 600 | 73 | 1746 | CATTLE | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |
| 600 | 74 | 1748 | CATTLE | FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS FLOCCULATION CATTLE FL |
| 600 | 74 | 1751 | CATTLE | CHEMICAL CHANGES IN SOILS USED FOR BEEF MANURE DISPOSAL KEYWORDS CATTLE WASTE-DISPOSAL |
| 600 | 74 | 1756 | CATTLE | ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN |
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| 300 | 73 | 1764 | CATTLE | DAIRY WASTE MANAGEMENT KEYWORDS WASTE-MANAGEMENT DAIRY-INDUSTRY CATTLE WATER-POLLUTIO |
| 400 | 74 | 1765 | CATTLE | MANURE GASES KILL 25 HEAD IN OHIO KEYWORDS MANURE GASES CATTLE OHIO MORTALITY SLATTED |
| 100 | 73 | 1773 | CATTLE | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS KEYWORDS DAIRY-INDUSTR |
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300 72 1802  CATTLE     ENVIRONMENTAL ECONOMIC AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE M
600 73 1803  CATTLE     FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE C
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100 71 2782 CHEMICAL-LOADING LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS KEYWORDS COMPUTER-MODELS WASTE-
600 74 2119 CHEMICAL-ODOR-CONT CHEMICAL CONTROL OF MANURE ODOR KEYWORDS ODOR ENZYMES CHEMICAL-ODOR-CONTROL MANURE MA
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300 73 1881 CHEMICAL-OXYGEN-DE A RECIRCULATING WASTE SYSTEM FOR SWINE UNITS KEYWORDS SWINE WASTE-TREATMENT OXIDATION
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600 74 1684 CHEMICAL-PROPERTIE OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL
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100 74 2064 CHEMICAL-PROPERTIE CORN SILAGE YIELD AND SOIL CHEMICAL PROPERTIES AS AFFECTED BY CATTLE FEEDLOT MANURE KE
600 74 2068 CHEMICAL-PROPERTIE EFFECT OF A LIVESTOCK WINTERING OPERATION ON A WESTERN MOUNTAIN STREAM KEYWORDS STREA
300 71 2076 CHEMICAL-PROPERTIE BEEF FEEDLOTS-A POLLUTION PROBLEM KEYWORDS FEEDLOTS MANAGEMENT WATER-POLLUTION AIR-PO
300 2085 CHEMICAL-PROPERTIE DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL-
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200 74 2138 CHEMICAL-PROPERTIE COMPOSITION OF WASTE AS EXCRETED CHANGES DURING STORAGE AND ODOR DEVELOPMENT KEYWORDS
200 74 2144 CHEMICAL-PROPERTIE EFFECT OF HOUSING TYPE ON NUTRIENT COMPOSITION OF BEEF CATTLE MANURE KEYWORDS HOUSING
200 74 2145 CHEMICAL-PROPERTIE UTILIZING THE NUTRIENTS IN ANIMAL MANURES KEYWORDS ANIMAL-WASTES SOILS CHEMICAL-PROPER
200 63 2155 CHEMICAL-PROPERTIE FOWL FECAL FACTS KEYWORDS POULTRY PHYSICAL-PROPERTIES CHEMICAL-PROPERTIES BIOCHEMICAL
200 63 2156 CHEMICAL-PROPERTIE MANURE DISPOSAL LAGOONS KEYWORDS LAGOONS WASTE-TREATMENT WASTE-DISPOSAL CHEMICAL-PRO

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| | | | | |
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| 200 | 72 | 2174 | CHEMICAL-PROPERTIE | A SYSTEMS APPROACH TO CATTLE FEEDLOT POLLUTION CONTROL KEYWORDS CATTLE FEEDLOTS WATER- |
| 600 | 72 | 2195 | CHEMICAL-PROPERTIE | ROOFED VS UNROOFED SOLID MANURE STORAGES FOR DAIRY CATTLE KEYWORDS WASTE-STORAGE DAIRY- |
| 100 | 75 | 2250 | CHEMICAL-PROPERTIE | CHEMICAL CHARACTERISTICS OF A FEEDLOT SOIL PROFILE KEYWORDS FEEDLOTS SOIL-PROFILES CH |
| 300 | 72 | 2261 | CHEMICAL-PROPERTIE | DISPOSAL OF FARM ANIMAL WASTES THROUGH THE SOIL KEYWORDS WASTE-DISPOSAL CATTLE DAIRY-I |
| 100 | 73 | 2277 | CHEMICAL-PROPERTIE | LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A |
| 600 | 74 | 2285 | CHEMICAL-PROPERTIE | POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS KEYWORDS POULTRY WAST |
| 300 | 71 | 2286 | CHEMICAL-PROPERTIE | IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE |
| 700 | 63 | 2311 | CHEMICAL-PROPERTIE | CHARACTERISTICS AND TREATMENT OF WASTES FROM A CONFINEMENT HOG PRODUCTION UNIT KEYWOR |
| 700 | 72 | 2316 | CHEMICAL-PROPERTIE | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 600 | 72 | 2329 | CHEMICAL-PROPERTIE | CONVERTING ORGANIC WASTES TO OIL KEYWORDS RECYCLING ORGANIC-WASTES OIL CELLULOSE CATT |
| 600 | 68 | 2370 | CHEMICAL-PROPERTIE | MANAGEMENT AND UTILIZATION OF POULTRY WASTES KEYWORDS LITTER WASTE-TREATMENT WASTE-DIS |
| 100 | 74 | 2400 | CHEMICAL-PROPERTIE | REVIEW PAPER-ANIMAL WASTES MANAGEMENT AND CHARACTERIZATION KEYWORDS FARM-WASTES PHYSI |
| 100 | 75 | 2422 | CHEMICAL-PROPERTIE | WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS |
| 700 | 70 | 2455 | CHEMICAL-PROPERTIE | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE KEYWOR |
| 200 | 74 | 2462 | CHEMICAL-PROPERTIE | PRODUCTION OF METHANE FROM POULTRY MANURE KEYWORDS METHANE RESEARCH-AND-DEVELOPMENT C |
| 200 | 74 | 2470 | CHEMICAL-PROPERTIE | WASTE HANDLING AND LAGOON MANAGEMENT KEYWORDS LAGOONS FEEDLOTS DESIGN CHEMICAL-PROPER |
| 200 | 73 | 2486 | CHEMICAL-PROPERTIE | SUMMARY OF KANSAS EXPERIENCE WITH LIQUID WASTE SPREADING KEYWORDS KANSAS AGRICULTURAL- |
| 300 | 73 | 2498 | CHEMICAL-PROPERTIE | SYNTHESIS GAS FROM FEEDLOT MANURE-A CONCEPTUAL DESIGN STUDY KEYWORDS DESIGN EQUIPMENT |
| 100 | 74 | 2515 | CHEMICAL-PROPERTIE | PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE F |
| 300 | 74 | 2526 | CHEMICAL-PROPERTIE | COMPOSITION AND DIGESTIBILITY OF CATTLE FECAL WASTE KEYWORDS CATTLE CHEMICAL-PROPERTI |
| 700 | 72 | 2560 | CHEMICAL-PROPERTIE | THE EFFECT OF DEHYDRATION ON THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF MANURE KE |
| 100 | 72 | 2580 | CHEMICAL-PROPERTIE | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE |
| 200 | 75 | 2646 | CHEMICAL-PROPERTIE | MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE |
| 200 | 75 | 2650 | CHEMICAL-PROPERTIE | THE INCLUSION OF PIG MANURE IN RUMINANT DIETS KEYWORDS DIETS CATTLE CHEMICAL-PROPERTIE |
| 200 | 75 | 2675 | CHEMICAL-PROPERTIE | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 200 | 75 | 2687 | CHEMICAL-PROPERTIE | DECOMPOSITION RATES OF BEEF CATTLE WASTES KEYWORDS ORGANIC-WASTES CATTLE RECYCLING CHE |
| 200 | 75 | 2688 | CHEMICAL-PROPERTIE | CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE KEYWORD |
| 200 | 75 | 2701 | CHEMICAL-PROPERTIE | EVAPORATION OF WATER FROM HOLDING PONDS KEYWORDS EVAPORATION PHYSICAL-PROPERTIES CHEM |
| 200 | 75 | 2712 | CHEMICAL-PROPERTIE | PROPERTIES OF SOLIDS AND LIQUIDS FROM STACKED MANURE KEYWORDS SOLID-WASTES LIQUID-WAST |
| 200 | 75 | 2730 | CHEMICAL-PROPERTIE | INVESTIGATIONS ON THE PROCEDURE AND THE TURN-OVER OF ORGANIC MATTER BY HOT FERMENTATION |
| 200 | 75 | 2737 | CHEMICAL-PROPERTIE | SLUDGE MANAGEMENT FOR ANAEROBIC DAIRY WASTE LAGOONS KEYWORDS SLUDGE ANAEROBIC-LAGOONS |
| 200 | 75 | 2738 | CHEMICAL-PROPERTIE | TRENDS AND VARIATIONS IN AN ANAEROBIC LAGOON WITH RECYCLING KEYWORDS LAGOONS ANAEROBI |
| 200 | 75 | 2748 | CHEMICAL-PROPERTIE | PRESENT KNOWLEDGE ON THE EFFECTS OF LAND APPLICATION OF ANIMAL WASTE KEYWORDS ANIMAL- |
| 200 | 75 | 2756 | CHEMICAL-PROPERTIE | SOIL PROPERTIES AND FUTURE CROP PRODUCTION AS AFFECTED BY MAXIMUM RATES OF DAIRY MANURE |
| 200 | 75 | 2757 | CHEMICAL-PROPERTIE | COMPOSITION OF POULTRY MANURE AND EFFECT OF HEAVY APPLICATION ON SOIL CHEMICAL PROPERTI |
| 700 | 64 | 2768 | CHEMICAL-PROPERTIE | CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT |
| 700 | 71 | 2780 | CHEMICAL-PROPERTIE | AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS KEYWORDS ODOR CONFINEMENT-PENS F |
| 100 | 71 | 2806 | CHEMICAL-PROPERTIE | AN ECOLOGICAL BLUEPRINT FOR TODAY KEYWORDS WASTE-DISPOSAL SAMPLING CHEMICAL-PROPERTIE |
| 100 | 71 | 2807 | CHEMICAL-PROPERTIE | INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIAL |
| 100 | 72 | 2811 | CHEMICAL-PROPERTIE | THE USE OF ANIMAL WASTES ON FERTILIZER KEYWORDS FERTILIZERS IRRIGATION ANIMAL-WASTES |
| 200 | 69 | 1902 | CHEMICAL-REACTIONS | WHAT HAPPENS IN THE SOIL WHEN MANURE IS USED KEYWORDS SOILS BACTERIA CHEMICAL-REACTION |
| 100 | 66 | 2513 | CHEMICAL-REACTION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION O |
| 300 | 73 | 1051 | CHEMICAL-TREATMENT | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 400 | 71 | 1935 | CHEMICAL-TREATMENT | BARN WASTES FOR FEED KEYWORDS FEEDS RUMINANTS BARN-WASTES REFEEDING DIGESTIBILITY CHE |
| 100 | 74 | 2403 | CHEMICAL-TREATMENT | TECHNICAL ASPECTS OF LIQUID COMPOSTING KEYWORDS DAIRY-INDUSTRY ODOR BIOLOGICAL-TREATM |
| 400 | 75 | 2459 | CHEMICAL-TREATMENT | PAUNCH FEEDING NOW PROFITABLE KEYWORDS ECONOMICS CATTLE REFEEDING PAUNCH-MANURE BLOOD |
| 200 | 75 | 2694 | CHEMICAL-TREATMENT | MALODOR REDUCTION IN BEEF CATTLE FEEDLOTS KEYWORDS FEEDLOTS CATTLE ODOR-CONTROL CHEMIC |
| 200 | 75 | 2696 | CHEMICAL-TREATMENT | ODOR CONTROL OF LIQUID DAIRY AND SWINE MANURE USING CHEMICAL AND BIOLOGICAL TREATMENTS |
| 200 | 75 | 2698 | CHEMICAL-TREATMENT | CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO REDUCE MALODORS KEYWORDS CHEMICAL-TREATME |
| 400 | 74 | 2093 | CHICKEN-LITTER | COMPOSTED CHICKEN LITTER [illegible] RECLAIM SALT DAMAGED LAND KEYWORDS SALTS RECLAMATIO |
| 100 | 71 | 2760 | CHICKEN-LITTER | POULTRY MANURE AS A LIVESTOCK FEED PART 1 KEYWORDS POULTRY LIVESTOCK REFEEDING HEN-LAY |
| 200 | 63 | 2166 | CHICKEN-WASTES | ODORS AND AIR POLLUTION KEYWORDS WASTES POULTRY AIR-POLLUTION ODOR ODOR-CONTROL ODOR- |
| 100 | 73 | 2259 | CHICKS | BACTERIAL CONTAMINATION OF HATCHING EGGS AND CHICKS PRODUCED BY BROILER BREEDERS HOUSED |
| 400 | 73 | 1957 | CHINO-CORONA-AREA | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 700 | 71 | 1689 | CHLORIDES | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 600 | 72 | 1893 | CHLORIDES | LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD |
| 600 | 73 | 2245 | CHLORIDE | GROUNDWATER QUALITY BENEATH A MANURE DISPOSAL AREA KEYWORDS WASTE-DISPOSAL NUTRIENTS N |
| 200 | 75 | 2670 | CHLORIDE | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORDS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2671 | CHLORIDE | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 400 | 71 | 1898 | CHLORINATION | ANIMAL WASTE DISPOSAL KEYWORDS ANIMAL-WASTES WASTE-DISPOSAL CANADA AEROBIC-TREATMENT |
| 600 | 66 | 2194 | CHLORINATION | TREATMENT OF LIQUID HOG MANURE TO SUPPRESS ODORS KEYWORDS WASTE-TREATMENT LIQUID-WAST |
| 700 | 70 | 2406 | CHLORTETRACYCLINE | EFFECT OF ANTIBIOTIC SUPPLEMENTATION ON THE DECOMPOSITION OF ANIMAL WASTES KEYWORDS A |
| 900 | 72 | 2372 | CHLORTETRACYCLINE- | INFLUENCE OF AN ANTIBIOTIC ON THE PERFORMANCE OF YEARLING HOLSTEIN STEERS KEYWORDS AN |
| 700 | 64 | 1735 | CHROMATOGRAPHY | ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING KEYWORDS ODOR SWINE CONFINEMENT-HOUSING |
| 200 | 73 | 1789 | CHROMATOGRAPHY | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
| 700 | 68 | 1826 | CHROMATOGRAPHY | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 300 | 71 | 2286 | CHROMATOGRAPHY | IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE |
| 700 | 71 | 2308 | CHROMATOGRAPHY | NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA |
| 700 | 71 | 2309 | CHROMATOGRAPHY | IDENTIFICATION AND CONTROL OF CATTLE FEEDLOT ODORS KEYWORDS ODOR FEEDLOTS CATTLE GASE |
| 300 | 69 | 2078 | CIVIL-COURTS | WATER POLLUTION LAWS AND REGULATIONS KEYWORDS WATER-POLLUTION REGULATION MISSOURI PER |
| 200 | 75 | 2744 | CLARIFICATION | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 700 | 73 | 2061 | CLARIFIERS | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF KEYWORDS BIOLOGICAL-TREATMENT AGRICULTURAL-RUN |
| 200 | 75 | 2671 | CLAY-LINER | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 200 | 64 | 1698 | CLEANING | HYDRAULIC COLLECTION OF POULTRY WASTE KEYWORDS POULTRY HYDRAULIC-COLLECTION ODOR DESI |
| 200 | 64 | 1700 | CLEANING | HYDRAULIC MANURE SYSTEMS KEYWORDS HYDRAULICS WASTE-HANDLING ODOR DESIGN CLEANING LIQU |
| 400 | 73 | 1894 | CLEANING | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES KEYWORDS AMMONIA LITTER BROILERS V |
| 400 | 72 | 1963 | CLEANING | CLEANEST FEEDLOT IN KANSAS KEYWORDS KANSAS FEEDLOTS AGRICULTURAL-RUNOFF LAGOONS COSTS |
| 300 | 72 | 2533 | CLEANING | DAIRY WASTE STORAGE PONDS FOR SOIL PLANT RECYCLING KEYWORDS DAIRY-INDUSTRY WASTE-STOR |
| 100 | 69 | 2542 | CLEANING | DEVELOPMENTS IN HOG MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS CLEANING DESIGN S |
| 700 | 71 | 1732 | CLEANLINESS | PHOTOGRAPHIC STUDIES OF THE DUNGING BEHAVIOR OF PIGS IN CONFINEMENT KEYWORDS SWINE CO |
| 200 | 71 | 1969 | CLEANLINESS | WHAT OUR MILK MARKETS REQUIRE KEYWORDS MILK WASTE-DISPOSAL REGULATION DAIRY-INDUSTRY |
| 600 | 74 | 1712 | CLIMATES | MOVEMENT OF MANURIAL NITROGEN IN COOL HUMID CLIMATES KEYWORDS MODEL-STUDIES NITROGEN M |
| 600 | 73 | 1844 | CLIMATES | FORMS OF NITROGEN IN ANIMAL WASTE KEYWORDS NITROGEN-COMPOUNDS WASTE-TREATMENT WASTE-S |
| 200 | 72 | 1880 | CLIMATES | EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES |
| 400 | 70 | 1947 | CLIMATES | LITTLE POLLUTION FROM THIS FEEDLOT KEYWORDS FEEDLOTS NEBRASKA ANALYSIS NITRATES GASES |
| 300 | 71 | 2076 | CLIMATES | BEEF FEEDLOTS-A POLLUTION PROBLEM KEYWORDS FEEDLOTS MANAGEMENT WATER-POLLUTION AIR-PO |
| 200 | 63 | 2194 | CLIMATES | WASTE MANAGEMENT PROBLEMS ON THE FARM KEYWORDS POULTRY SPREADING SPRAYING HYDRAULIC-C |
| 200 | 69 | 2221 | CLIMATES | WASTE CONTROL ALTERNATIVES KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS LAGOONS TOPOGRAPHY C |
| 200 | 75 | 2600 | CLIMATES | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |
| 200 | 75 | 2688 | CLIMATES | CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE KEYWORD |
| 200 | 75 | 2708 | CLIMATES | MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES KEYWORDS IR |
| 600 | 72 | 1752 | CLIMATE | ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE KEYWORDS AERATION LARVAE F |
| 300 | 72 | 2086 | CLIMATE | HYDROLOGY AND CHARACTERISTICS OF FEEDLOT RUNOFF KEYWORDS HYDROLOGY FEEDLOTS AGRICULTUR |
| 200 | 74 | 2144 | CLIMATE | EFFECT OF HOUSING TYPE ON NUTRIENT COMPOSITION OF BEEF CATTLE MANURE KEYWORDS HOUSING |
| 600 | 74 | 1684 | CLIMATIC-CONDITION | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 600 | 71 | 2778 | CLIMATIC-DATA | A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT |
| 300 | 73 | 1617 | CLIMATIC-PATTERNS | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 300 | 74 | 1889 | CLIMATOLOGY | AGRICULTURAL ANIMALS AND THE ENVIRONMENT KEYWORDS FEEDLOTS MANAGEMENT AIR-POLLUTION W |
| 200 | 71 | 1927 | CLIMATOLOGY | REDUCTION OF FEEDLOT WASTE BY STABILIZATION KEYWORDS FEEDLOTS CATTLE WASTE-MANAGEMENT |
| 600 | 72 | 1992 | CLIMATOLOGY | EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM KEYWORDS CLIMATOLOGY FEEDL |

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| 200 | 73 | 2441 | CLOGGING | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 200 | 75 | 2621 | CLOGGING | A WASTE MANAGEMENT SYSTEM FOR A 150-COW DAIRY-A 10 YEAR CASE STUDY KEYWORDS DAIRY-IND |
| 200 | 74 | 2469 | CLOSED-ECOLOGICAL- | ANIMAL WASTE HANDLING AND CAN THE TAIL WAG THE DOG KEYWORDS COSTS FEEDLOTS FERTILIZER |
| 400 | 75 | 2107 | CLOSED-SYSTEMS | FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED KEYWORDS DESIGN CONSTRUC |
| 400 | 74 | 1911 | CLOSED-SYSTEM | A CLOSED SYSTEM NEW IDEA IN POULTRY WASTE DISPOSAL KEYWORDS POULTRY RECYCLING EXCRETA |
| 600 | 67 | 1683 | CLOSE-CONFINEMENT- | PERFORMANCE OF EXPERIMENTAL CLOSE-CONFINEMENT CAGED CATTLE FEEDING SYSTEMS KEYWORDS |
| 700 | 73 | 1890 | COAGULATION | LABORATORY STUDIES ON FEEDLOT RUNOFF KEYWORDS ANIMAL-WASTES AGRICULTURAL-RUNOFF FEEDL |
| 700 | 72 | 2409 | COAGULATION | CHEMICAL COAGULATION OF FEEDLOT RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF CHEMICA |
| 100 | 69 | 2562 | COAGULATION | RESEARCH AND PRACTICE IN ANIMAL WASTES TREATMENT KEYWORDS ANIMAL-WASTES WASTE-TREATME |
| 200 | 75 | 2753 | COASTAL-BERMUDAGRA | PLANT AND SOIL EFFECTS OF SWINE LAGOON EFFLUENT APPLIED TO COASTAL BERMUDAGRASS KEYWO |
| 200 | 75 | 2675 | COASTAL-PLAINS | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 100 | 74 | 2047 | COBALT-MALYBDATE | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 600 | 73 | 1616 | COLD-BARNS | WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS KEYWORDS CATTLE CONFINEMENT-PENS PERFORM |
| 600 | 72 | 1886 | COLD-CONFINEMENT | SLOTTED FLOOR COLD CONFINEMENT BEEF CATTLE HOUSING KEYWORDS CATTLE DESIGN PERFORMANCE |
| 300 | 72 | 2369 | COLD-CONFINEMENT-B | COMPARISON OF HOUSING SYSTEMS FOR FEEDLOT CATTLE IN NORTHERN CLIMATES KEYWORDS PERFOR |
| 600 | 72 | 1753 | COLIFORMS | BUFFALO LAKE RECREATIONAL WATER QUALITY A STUDY IN BACTERIOLOGICAL DATA INTERPRETATION |
| 100 | 72 | 1788 | COLIFORMS | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 100 | 72 | 2110 | COLIFORMS | TOXICITY OF SEAWATER TO COLIFORM BACTERIA KEYWORDS TOXICITY SEAWATER COLIFORMS BACTER |
| 300 | 68 | 2220 | COLIFORMS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 700 | 71 | 2307 | COLIFORMS | FECAL COLIFORM POLLUTION IN AN AGRICULTURAL ENVIRONMENT KEYWORDS WATER-POLLUTION AGRIC |
| 200 | 70 | 2347 | COLIFORMS | CONCENTRATIONS AND CYCLES OF BACTERIAL INDICATORS IN FARM SURFACE RUNOFF KEYWORDS WAT |
| 100 | 75 | 2419 | COLIFORMS | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 300 | 71 | 2451 | COLIFORMS | LIVESTOCK FEEDLOTS ARE POLLUTION SOURCE KEYWORDS FEEDLOTS WATER-POLLUTION MINNESOTA BI |
| 100 | 74 | 2502 | COLIFORMS | A SURVEY OF EFFECTS OF ANIMAL WASTES ON STREAM POLLUTION FROM SELECTED DAIRY FARMS KEY |
| 300 | 74 | 2528 | COLIFORMS | POLLUTANT MOVEMENT TO GROUND WATER FROM SWINE WASTE LAGOONS KEYWORDS GROUNDWATER-POLLU |
| 200 | 75 | 2652 | COLIFORMS | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2654 | COLIFORMS | HEALTH ASPECTS OF FEEDING ANIMAL WASTE CONSERVED IN SILAGE KEYWORDS PERFORMANCE SALMON |
| 200 | 75 | 2670 | COLIFORMS | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORDS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2674 | COLIFORMS | EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED |
| 200 | 75 | 2675 | COLIFORMS | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 200 | 75 | 2676 | COLIFORMS | NUTRIENT CHARACTERISTICS OF WASTES FROM DEEP PITS AND ANAEROBIC LAGOONS KEYWORDS LAGO |
| 200 | 75 | 2679 | COLIFORMS | BACTERIAL ANALYSIS AND LAND DISPOSAL OF FARM WASTE LAGOON WATERS KEYWORDS LAGOONS BAC |
| 600 | 71 | 1719 | COLLECTION | SWINE MANURE COLLECTION AND REMOVAL SYSTEMS KEYWORDS SWINE COLLECTION REMOVAL CONFINEM |
| 200 | 73 | 2482 | COLLECTION | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 100 | 74 | 2784 | COLLECTION | REGIONAL MANAGEMENT OF ANIMAL MANURES-A MODEL FOR COLLECTION STORAGE LOCATION AND DISTR |
| 600 | 74 | 1846 | COLLECTION-BASINS | RISER INTAKE DESIGNS FOR FEEDLOT SOLIDS COLLECTION BASINS KEYWORDS FEEDLOTS SOLID-WAST |
| 100 | 73 | 2431 | COLLECTION-INTERVA | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 100 | 73 | 2113 | COLLOIDAL-DISPERSI | EFFECTS OF APPLICATION RATE IN DIRECT LAND DISPOSAL OF ANIMAL WASTES KEYWORDS EFFECTS |
| 700 | 69 | 1690 | COLLOIDAL-SUSPENSI | ZETA POTENTIAL OF COLOIDAL SUSPENSIONS FROM A BEEF CATTLE FEEDLOT SURFACE KEYWORDS ZE |
| 400 | 72 | 1942 | COLORADO | THAT INESCAPABLE BYPRODUCT KEYWORDS DESIGN FEEDLOTS COLORADO RUNOFF-CONTROL LAND-DISP |
| 200 | 74 | 1986 | COLORADO | DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS WASTE-DISPOSAL RE |
| 300 | 75 | 2339 | COLORADO | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 100 | 73 | 2348 | COLORADO | ULTIMATE IN RECYCLING KEYWORDS RECYCLING FEEDS RECLAMATION ECONOMICS FEEDLOTS CHEMICA |
| 400 | 75 | 2560 | COLORADO | COLORADO OPW PROCESSING FIRM FINDS READY MARKET AS BOTH FEED FERTILIZER KEYWORDS COLO |
| 200 | 75 | 2755 | COLORADO | ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION KEYW |
| 700 | 74 | 2405 | COLOR | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 700 | 72 | 2409 | COLOR-REDUCTION | CHEMICAL COAGULATION OF FEEDLOT RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF CHEMICA |
| 700 | 73 | 2385 | COLO-SILTY-CLAY-LO | PHYSICAL PROPERTIES OF A COLO SILTY CLAY LOAM SOIL DURING TWO YEARS IRRIGATION WITH EFF |
| 300 | 72 | 2063 | COMBUSTION | COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE KEYWORDS BURNING |
| 100 | 66 | 2513 | COMBUSTION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION D |
| 600 | 72 | 2489 | COMFORT-ZONE | PLANNING CONSIDERATIONS FOR CONFINEMENT SWINE FACILITIES KEYWORDS CONFINEMENT-PENS PL |
| 100 | 67 | 2192 | COMMERCIAL | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 600 | 74 | 1749 | COMMERCIAL-CATFISH | A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH PONDS KEYWORDS EFFLUENT F |
| 600 | 72 | 1875 | COMMERCIAL-FISH | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 300 | | 2571 | COMMON-LAW | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 300 | 72 | 2088 | COMMUNICATIONS | ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS KEYWORDS LIQUID-WAST |
| 100 | 74 | 2222 | COMPACTIBILITY | COMPARATIVE CHANGES IN SOIL PHYSICAL PROPERTIES INDUCED BY ADMIXTURES OF MANURE FROM V |
| 200 | 73 | 2441 | COMPACTION | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 300 | 74 | 2118 | COMPARATIVE-BENEFI | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 600 | 74 | 1916 | COMPOSITIONAL-CHAN | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY REFEEDING |
| 200 | 74 | 2007 | COMPOSITION | THE PRODUCTION RATE AND COMPOSITION OF MANURE FROM GROWING TURKEYS KEYWORDS NUTRIENT |
| 100 | 74 | 2253 | COMPOSITION | ELEMENTAL COMPOSITION OF PARTICULATES NEAR A BEEF CATTLE FEEDLOT KEYWORDS DUSTS FEEDL |
| 300 | 74 | 2452 | COMPOSITION | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 200 | 75 | 2667 | COMPOSITION | THE YIELD RESPONSE OF GRASS TO AEROBICALLY STABILIZED SWINE WASTE KEYWORDS CROP-RESPO |
| 400 | 74 | 1626 | COMPOSTING | MANURE HANDLING SYSTEMS FOR THE FUTURE KEYWORDS MANURE WASTE-HANDLING RECYCLING LAGOO |
| 400 | 74 | 1630 | COMPOSTING | MANURE AS A FUEL KEYWORDS FUELS MANURE WASTE-TREATMENT WASTE-DISPOSAL COMPOSTING AGRI |
| 200 | 74 | 1649 | COMPOSTING | COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE KEYWORDS MUNICIPAL-WASTES FEEDLOTS FARM-W |
| 100 | 72 | 1657 | COMPOSTING | MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT SLURRY KEYWORDS NITROGEN FERTIL |
| 700 | 71 | 1688 | COMPOSTING | THE AEROBIC DECOMPOSITION OF SOLID BEEF CATTLE FEEDLOT WASTE KEYWORDS AEROBIC-TREATME |
| 300 | 73 | 1764 | COMPOSTING | DAIRY WASTE MANAGEMENT KEYWORDS WASTE-MANAGEMENT DAIRY-INDUSTRY CATTLE WATER-POLLUTIO |
| 200 | 70 | 1805 | COMPOSTING | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 100 | 73 | 1806 | COMPOSTING | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 400 | 74 | 1827 | COMPOSTING | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AER |
| 300 | 71 | 1865 | COMPOSTING | ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL KEYWORDS POULTRY NITROGEN CARBON A |
| 300 | 72 | 1878 | COMPOSTING | MAINE GUIDELINES FOR MANURE SLUDGE DISPOSAL ON LAND KEYWORDS MANURE SLUDGE MAINE LAND |
| 300 | 66 | 1897 | COMPOSTING | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION KEYWORDS POULTRY CHE |
| 100 | 71 | 1902 | COMPOSTING | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 200 | 71 | 1927 | COMPOSTING | REDUCTION OF FEEDLOT WASTE BY STABILIZATION KEYWORDS FEEDLOTS CATTLE WASTE-MANAGEMENT |
| 200 | 69 | 1980 | COMPOSTING | THE REUSE OF OLD LITTER KEYWORDS LITTER POULTRY REUSE BUILT-UP-LITTER MAREKS-DISEASE |
| 300 | 74 | 2044 | COMPOSTING | LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS KEYWORDS LIQ |
| 300 | | 2085 | COMPOSTING | DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL- |
| 400 | 75 | 2107 | COMPOSTING | FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED KEYWORDS DESIGN CONSTRUC |
| 400 | 74 | 2114 | COMPOSTING | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 500 | 74 | 2132 | COMPOSTING | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
| 200 | 63 | 2165 | COMPOSTING | UTILIZATION AND DISPOSAL OF POULTRY MANURE KEYWORDS POULTRY WASTE-DISPOSAL AERATION M |
| 300 | 74 | 2177 | COMPOSTING | RECYCLING POULTRY WASTE AS FEED WILL IT PAY KEYWORDS RECYCLING FEEDS ECONOMICS INCINER |
| 100 | 72 | 2197 | COMPOSTING | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
| 300 | 74 | 2219 | COMPOSTING | DIGESTIBILITY OF CATTLE FEEDLOT WASTE KEYWORDS ANIMAL-WASTES CATTLE FEEDLOTS RATIONS |
| 400 | 71 | 2237 | COMPOSTING | COMPOSTING POULTRY MANURE IN DEEP PITS KEYWORDS COMPOSTING POULTRY WASTE-STORAGE ODOR |
| 300 | 72 | 2313 | COMPOSTING | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 72 | 2359 | COMPOSTING | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR |
| 100 | 69 | 2380 | COMPOSTING | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS KEYWORDS WAST |
| 300 | 74 | 2382 | COMPOSTING | ANIMAL WASTE MANAGEMENT WITH POLLUTION CONTROL KEYWORDS LAGOONS ECONOMICS ODOR OHIO SO |
| 100 | 74 | 2403 | COMPOSTING | TECHNICAL ASPECTS OF LIQUID COMPOSTING KEYWORDS DAIRY-INDUSTRY ODOR BIOLOGICAL-TREATM |
| 400 | 73 | 2416 | COMPOSTING | POULTRY MANURE COMPOSTING KEYWORDS AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST |
| 300 | 75 | 2426 | COMPOSTING | USE OF SLUDGE RELIEVES FERTILIZER SHORTAGE KEYWORDS RECYCLING ENERGY FERTILIZERS SLUDG |
| 400 | 71 | 2454 | COMPOSTING | WHY WASTE ANIMAL WASTES KEYWORDS WASTE-DISPOSAL RECYCLING LAGOONS ANIMAL-WASTES ECOLI |
| 200 | 74 | 2469 | COMPOSTING | ANIMAL WASTE HANDLING AND CAN THE TAIL WAG THE DOG KEYWORDS COSTS FEEDLOTS FERTILIZER |
| 400 | 60 | 2539 | COMPOSTING | MANURE DISPOSAL POSES PROBLEM KEYWORDS POULTRY WASTE-DISPOSAL FERTILIZERS COSTS ECONO |
| 200 | 64 | 2565 | COMPOSTING | SANITARY ENGINEERING IN AGRICULTURE KEYWORDS DRYING ODOR LAGOONS AGRICULTURAL-WASTES |

# KEYWORD INDEX

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200 75 2705  COMPOSTING         LIVESTOCK AGRICULTURE IN THE STATE OF HAWAII A REGIONAL APPROACH TO WASTE MANAGEMENT  K
200 75 2723  COMPOSTING         DRYING DAIRY WASTES WITH SOLAR ENERGY  KEYWORDS  DRYING COSTS COMPOSTING RECYCLING DAIR
200 75 2724  COMPOSTING         HIGH RATE MECHANIZED COMPOSTING OF DAIRY MANURE KEYWORDS  DESIGN MODEL-STUDIES COMPOSTI
200 75 2725  COMPOSTING         AEROBIC COMPOSTING-NEW BUILT-UP BED TECHNIQUE  KEYWORDS AEROBIC-CONDITIONS EQUIPMENT DE
200 75 2726  COMPOSTING         CONSERVATION OF NITROGEN IN DAIRY MANURE DURING COMPOSTING  KEYWORDS  NITROGEN DAIRY-IN
200 75 2727  COMPOSTING         COMPOSTING SWINE WASTE  KEYWORDS  YIELDS COMPOSTING SWINE WINDROW-TECHNIQUE BULKING-MAT
200 75 2728  COMPOSTING         LIQUID COMPOSTING OF DAIRY MANURE  KEYWORDS  LIQUID-WASTES  DAIRY-INDUSTRY CALIFORNIA E
200 75 2729  COMPOSTING         LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES  KEYWORDS  LIQUID-WASTES EQUIPMENT AER
100 73 2779  COMPOSTING         HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE  KEYWORDS  COMPOSTING MUNIC
100 70 2786  COMPOSTING         TREATMENT AND DISPOSAL OF ANIMAL WASTES  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL ANIMA
100 71 2787  COMPOSTING         WINTER HIGH RATE COMPOSTING OF BROILER MANURE  KEYWORDS WINTER FARM-WASTES WASTE-TREATM
100 68 2788  COMPOSTING         THE FLOW OF SOLID WASTES IN PIPELINES  KEYWORDS SOLID-WASTES HYDRAULIC-TRANSPORTATION P
400 71 2810  COMPOSTING         LIVESTOCK WASTE-WHY WASTE IT  KEYWORDS  WASTE-DISPOSAL LIVESTOCK ECONOMICS LAGOONS DEHY
400 74 2093  COMPOST            COMPOSTED CHICKEN LITTER SEEMS TO RECLAIM SALT DAMAGED LAND  KEYWORDS  SALTS RECLAMATIO
100 74 2236  COMPOST            USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS  KEYWORDS  RECLAMATION POUL
200 75 2623  COMPOST            A PLANNING STUDY ON DAIRY WASTES MANAGEMENT  KEYWORDS DAIRY-INDUSTRY CALIFORNIA WATER-P
600 73 1763  COMPUTATION        DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR  KEYWORDS  DRYING FA
700 67 2228  COMPUTERS          ANNUAL TOTALS AND TEMPORAL DISTRIBUTION OF CATTLE FEEDLOT RUNOFF IN KANSAS  KEYWORDS  A
600 73 1848  COMPUTER-MODELS    MODEL OF NITRATE PRODUCTION AND MOVEMENT IN MANURE DISPOSAL PLOTS  KEYWORDS  COMPUTER-M
200 74 2009  COMPUTER-MODELS    EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATIO
700 74 2362  COMPUTER-MODELS    NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS  FARM-WASTES WATER-POLL
100 71 2782  COMPUTER-MODELS    LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS  KEYWORDS  COMPUTER-MODELS WASTE-
200 75 2707  COMPUTER-SIMULATIO A COMPUTER SIMULATION OF STORAGE AND LAND DISPOSAL OF SWINE WASTE  KEYWORDS  WASTE-STOR
600 73 1763  COMPUTER-STUDY     DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR  KEYWORDS  DRYING FA
600 64 2204  CONCENTRATIONS     AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING  KEYWORDS  AIR-POLLUTION LI
100 73 1660  CONCENTRATION      FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAM
700 64 1735  CONCRETE-FLOOR     ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING  KEYWORDS ODOR SWINE CONFINEMENT-HOUSING
300 68 1948  CONCRETE-SURFACE   THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF MAN
100 74 2064  CONDUCTANCE        CORN SILAGE YIELD AND SOIL CHEMICAL PROPERTIES AS AFFECTED BY CATTLE FEEDLOT MANURE  KE
100 74 2236  CONDUCTIVITY       USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS  KEYWORDS  RECLAMATION POUL
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200 75 2692  CONFINEMENT-BUILDI MANURE GASES AND AIR CURRENTS IN LIVESTOCK HOUSING  KEYWORDS LIVESTOCK VENTILATION HYDR
300 71 1850  CONFINEMENT-FEEDIN RULES AND REGULATIONS-CONFINED FEEDING OPERATIONS  KEYWORDS  REGULATION IOWA WASTE-WATE
400 74 2202  CONFINEMENT-FEEDIN NO PEN CLEANING COSTS  KEYWORDS  CONFINEMENT-PENS CATTLE KANSAS WASTE-DISPOSAL LAGOONS
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400 73 1615  CONFINEMENT-PENS   WILL A CONFINEMENT BARN PAY  KEYWORDS  CONFINEMENT-PENS ECONOMICS CATTLE COSTS OPEN-LOT
600 73 1616  CONFINEMENT-PENS   WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS  KEYWORDS CATTLE CONFINEMENT-PENS PERFORM
300 74 1619  CONFINEMENT-PENS   FERTILIZER VALUE OF DAIRY LOT MANURE  KEYWORDS  FERTILIZERS DAIRY-INDUSTRY CONFINEMENT-
700 69 1650  CONFINEMENT-PENS   CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS  CHEMICAL-OXYGEN-D
100 72 1681  CONFINEMENT-PENS   ANIMAL WASTE MANAGEMENT PROBLEMS AND GUIDELINES FOR SOLUTIONS  KEYWORDS  WASTE-MANAGEME
600 67 1683  CONFINEMENT-PENS   PERFORMANCE OF EXPERIMENTAL CLOSE-CONFINEMENT CAGED CATTLE  FEEDING SYSTEMS  KEYWORDS
700 66 1707  CONFINEMENT-PENS   AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS  KEYWO
600 71 1713  CONFINEMENT-PENS   ANIMAL WASTE MANAGEMENT CONFERENCE KEYWORDS  WASTE-MANAGEMENT LIVESTOCK CONFINEMENT-PEN
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600 71 1720  CONFINEMENT-PENS   NATURE AND BEHAVIOR OF MANURE  KEYWORDS  WATER-POLLUTION FEEDLOTS AGRICULTURAL-RUNOFF M
600 71 1722  CONFINEMENT-PENS   WASTE MANAGEMENT SYSTEMS FOR ROOFED BEEF CONFINEMENT FACILITIES  KEYWORDS  WASTE-MANAGE
600 71 1723  CONFINEMENT-PENS   SWINE SYSTEMS FOR IOWA AND NORTH CENTRAL STATES  KEYWORDS SWINE WASTE-MANAGEMENT IOWA E
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700 71 1732  CONFINEMENT-PENS   PHOTOGRAPHIC STUDIES OF THE DUNGING BEHAVIOR OF PIGS IN CONFINEMENT  KEYWORDS  SWINE CO
700 70 1736  CONFINEMENT-PENS   ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION  KEYWORDS  ODOR CONT
600 74 1738  CONFINEMENT-PENS   STORAGE LAGOON VERSUS UNDERFLOOR TANK FOR DAIRY CATTLE MANURE  KEYWORDS  WASTE-SOTRAGE
600 66 1743  CONFINEMENT-PENS   STRUCTURAL ANALYSIS OF FLOOR GRIDS FOR CONFINEMENT CATTLE FEEDING SYSTEMS  KEYWORDS  CO
600 73 1763  CONFINEMENT-PENS   DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR  KEYWORDS  DRYING FA
700 71 1766  CONFINEMENT-PENS   WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
600 67 1780  CONFINEMENT-PENS   THE PROBLEM OF FARM ANIMAL WASTE DISPOSAL  KEYWORDS  WASTE-DISPOSAL LIVESTOCK POULTRY C
400 74 1781  CONFINEMENT-PENS   THEY RE GETTING THE JUMP ON POLLUTION CONTROLS  KEYWORDS WATER-POLLUTION CONTROL CONFIN
100 72 1788  CONFINEMENT-PENS   MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES  KEYWORDS  FEEDLOTS CATTLE A
200 72 1795  CONFINEMENT-PENS   HARVESTING NUTRIENTS FROM SWINE WASTES  KEYWORDS  NUTRIENTS SWINE WASTE-TREATMENT OXIDA
400 72 1807  CONFINEMENT-PENS   CONFINEMENT PAYS IF WEATHER IS BAD  KEYWORDS  CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL
400 73 1812  CONFINEMENT-PENS   FEEDING VARIATIONS CAN AFFECT WASTE  KEYWORDS  FEEDS FEED-LOTS CONFINEMENT-PENS TEXAS C
400 73 1817  CONFINEMENT-PENS   FLUSH SYSTEM CUTS CONFINEMENT COSTS  KEYWORDS  CONFINEMENT-PENS CATTLE COSTS FLUSH-SYST
400 73 1818  CONFINEMENT-PENS   BUDGET PRICED CONFINEMENT  KEYWORDS  CONFINEMENT-PENS COSTS ECONOMICS CATTLE WASTE-MANA
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| 600 | 71 | 2531 | CONFINEMENT-PENS | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEEDLOTS DESIGN-CRITERIA MONTANA ENGINE |
| 100 | 72 | 2580 | CONFINEMENT-PENS | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE |
| 700 | 73 | 2583 | CONFINEMENT-PENS | CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK |
| 200 | 75 | 2594 | CONFINEMENT-PENS | ECONOMICS OF ALTERNATIVE BEEF WASTE MANAGEMENT SYSTEMS KEYWORDS ECONOMICS CATTLE FEEDL |
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| 200 | 75 | 2689 | CONFINEMENT-PENS | IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR |
| 700 | 71 | 2771 | CONFINEMENT-PENS | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 700 | 71 | 2780 | CONFINEMENT-PENS | AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS KEYWORDS ODOR CONFINEMENT-PENS F |
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| 200 | 70 | 2392 | CONNECTICUT | A PERSPECTIVE FOR CONNECTICUT KEYWORDS CONNECTICUT POULTRY DAIRY-INDUSTRY AGRICULTURA |
| 200 | 70 | 2393 | CONNECTICUT | PLANT NUTRIENT BUDGETS AND WASTE DISPOSAL KEYWORDS NUTRIENTS WASTE-DISPOSAL NITROGEN |
| 100 | 72 | 2329 | CONSERVATION | CONVERTING ORGANIC WASTES TO OIL KEYWORDS RECYCLING ORGANIC-WASTES OIL CELLULOSE CATT |
| 200 | 73 | 2407 | CONSISTENCY | RETURNING ANIMAL WASTES TO THE LAND-EQUIPMENT CONSIDERATIONS KEYWORDS EQUIPMENT DESIG |
| 200 | 75 | 2641 | CONSTRAINTS | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 600 | 72 | 1624 | CONSTRUCTION | DRAINAGE SYSTEMS IN MILKING CENTERS KEYWORDS DRAINAGE-SYSTEMS DAIRY-INDUSTRY DESIGN S |
| 300 | 68 | 1625 | CONSTRUCTION | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 600 | 74 | 1686 | CONSTRUCTION | AEROBIC TREATMENT OF POULTRY WASTES KEYWORDS AEROBIC-TREATMENT FARM-WASTES POULTRY CO |
| 600 | 71 | 1737 | CONSTRUCTION | SLOTTED FLOORS FOR HOGS-PROGRESS AND TRENDS KEYWORDS SWINE DESIGN CONSTRUCTION SLOTTE |
| 700 | 71 | 1742 | CONSTRUCTION | A COMPARISON OF AN AERATED LAGOON AND IRRIGATION SYSTEM WITH A CONVENTIONAL SYSTEM FOR |
| 00 | 72 | 1804 | CONSTRUCTION | FEEDLOT DESIGN AND CONSTRUCTION KEYWORDS FEEDLOTS CONSTRUCTION DESIGN FACILITIES CATT |
| 300 | 73 | 1835 | CONSTRUCTION | STRUCTURES AND ENVIRONMENT HANDBOOK KEYWORDS PLANNING ENVIRONMENT WASTE-DISPOSAL DESI |
| 200 | 74 | 2033 | CONSTRUCTION | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 400 | 75 | 2107 | CONSTRUCTION | FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED KEYWORDS DESIGN CONSTRUC |
| 200 | 74 | 2152 | CONSTRUCTION | HANDLING DEHYDRATION AND UTILIZATION OF POULTRY WASTE KEYWORDS DEHYDRATION POULTRY REC |
| 400 | 72 | 2210 | CONSTRUCTION | STEP BY STEP PLAN FOR LIVESTOCK WASTE CONTROL KEYWORDS LIVESTOCK IOWA FEEDLOTS REGULAT |
| 200 | 74 | 2466 | CONSTRUCTION | HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE KEYWORDS CONFINEMENT-PENS DESIGN |
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| 200 | 75 | 2656 | CONSTRUCTION-WATER | SMALL METHANE GENERATOR FOR WASTE DISPOSAL KEYWORDS METHANE RECYCLING DESIGN SWINE TAI |
| 200 | 71 | 1964 | CONTAMINATION | MOVEMENT OF GROUND WATER KEYWORDS GROUNDWATER-POLLUTION MOVEMENT WASTE-DISPOSAL ANIMA |
| 400 | 72 | 2273 | CONTINUOUS-FEEDING | PROGRESS REPORTED IN HANDLING ANIMAL WASTES RECYCLING IN FEED KEYWORDS RECYCLING FEED |
| 200 | 75 | 2641 | CONTROLLED-STORAGE | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 300 | 74 | 1629 | CONTROL | CONTROL OF DUST FROM CATTLE FEEDLOTS KEYWORDS CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN |
| 600 | 74 | 1671 | CONTROL | PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS KEYWORDS FEEDLOTS AGRICULT |
| 200 | 64 | 1694 | CONTROL | ODORS AND THEIR CONTROL KEYWORDS ODOR CONTROL EQUIPMENT POULTRY EXCRETA FEATHERS ANAE |
| 600 | 71 | 1721 | CONTROL | DESIGN CONSIDERATIONS IN FEEDLOT RUNOFF CONTROL KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF |
| 700 | 70 | 1736 | CONTROL | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 600 | 74 | 1781 | CONTROL | THEY RE GETTING THE JUMP ON POLLUTION CONTROLS KEYWORDS WATER-POLLUTION CONTROL CONFIN |
| 300 | | 1792 | CONTROL | SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF |
| 300 | 74 | 1860 | CONTROL | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 200 | 74 | 2026 | CONTROL | APPROACHES FOR THE CONTROL OF NITROGEN WITH AN OXIDATION DITCH KEYWORDS NITROGEN CONT |
| 100 | 64 | 2079 | CONTROL | ODOR CONTROL IN CATTLE FEED YARDS KEYWORDS ODOR MECHANICAL-CONTROL LEGAL-ASPECTS SPRA |
| 400 | 74 | 2094 | CONTROL | NEW ODOR CONTROL PRODUCT NOW AVAILABLE KEYWORDS ODOR CONTROL BACTERIA FEEDLOTS FARM-W |
| 100 | 72 | 2190 | CONTROL | AGRICULTURAL RUNOFF CHARACTERISTICS AND CONTROL KEYWORDS AGRICULTURAL-RUNOFF CONTROL E |
| 200 | 71 | 2206 | CONTROL | PRINCIPLES OF NUTRIENT CONTROL FOR AGRICULTURAL WASTEWATERS KEYWORDS NUTRIENTS CONTRO |
| 100 | 66 | 2513 | CONTROL | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION D |
| 400 | 75 | 2120 | CONTROL-SYSTEMS | THE HIGH COST OF RUNOFF CONTROLS-IS HELP NEEDED KEYWORDS COSTS AGRICULTURAL-RUNOFF CON |
| 700 | 71 | 1864 | CONVERSION | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 100 | 72 | 2328 | CONVERSION | THE OIL CONVERSION PROCESS-AN ASSESSMENT KEYWORDS RECYCLING OIL LIVESTOCK AGRICULTURAL |
| 200 | 74 | 2457 | CONVERSION | PROCEEDINGS OF SYMPOSIUM ON THE CONVERSION OF POULTRY WASTE TO ENERGY FEED OR FERTILIZE |
| 200 | 74 | 2459 | CONVERSION | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 200 | 74 | 2029 | COPPER | WASTE TREATMENT WITH A PROTEIN BONUS KEYWORDS AEROBIC-TREATMENT PROTEINS NITRIFICATIO |
| 300 | 72 | 2371 | COPPER | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PHOS |
| 100 | 71 | 2402 | COPPER | BIODEGRADATION OF PIG WASTE BREAKDOWN OF SOLUBLE NITROGEN COMPOUNDS AND THE EFFECT OF C |
| 100 | 75 | 2490 | COPPER | EFFECTS OF BEEF FEEDLOT MANURE AND LAGOON WATER ON IRON ZINC MANGANESE AND COPPER CONTE |
| 100 | 72 | 2796 | COPPER | THE DISPOSAL OF COPPER ENRICHED PIG MANURE SLURRY ON GRASSLAND KEYWORDS COPPER SLURRI |
| 200 | 75 | 2650 | COPPER-BALANCE | THE INCLUSION OF PIG MANURE IN RUMINANT DIETS KEYWORDS DIETS CATTLE CHEMICAL-PROPERTIE |
| 200 | 74 | 2138 | COPROPHAGE | COMPOSITION OF WASTE AS EXCRETED CHANGES DURING STORAGE AND ODOR DEVELOPMENT KEYWORDS |
| 400 | 74 | 1771 | CORN | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 100 | 73 | 1800 | CORN | EFFECTS OF CONTINUOUS ZEA MAYS L MANURING AND NITROGEN FERTILIZATION ON YIELD AND PRO |
| 200 | 74 | 2031 | CORN | EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFFLUENT ON CORN AND GRAIN SORGHUM KEYWORDS |
| 100 | 75 | 2265 | CORN | SPRAY IRRIGATION OF DAIRY CATTLE MANURE EFFLUENT FOR MAXIMIZING CROP PRODUCTION KEYWOR |
| 100 | 73 | 2277 | CORN | LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A |
| 700 | 68 | 2317 | CORN | FERTILIZING VALUE OF CATTLE MANURE IN RELATION TO TREATMENT AND METHOD OF HANDLING KEY |
| 300 | 73 | 2395 | CORN | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 600 | 74 | 2396 | CORN | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 300 | 72 | 2371 | CORN | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PHOS |
| 300 | 72 | 2373 | CORN | FEEDING VALUE OF CORN RECLAIMED FROM AN OXIDATION DITCH AND THE INFLUENCE OF ADDING WAT |
| 700 | 70 | 2455 | CORN | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE KEYWOR |
| 700 | 74 | 2774 | CORN | EFFECTS OF OVERLOADING SWINE EFFLUENT ON TALL FESCUE REED CANARYGRASS AND CORN KEYWORD |
| 100 | 75 | 2813 | CORN | CORN RESPONSE AND SOIL NITROGEN TRANSFORMATIONS FOLLOWING VARIED APPLICATION OF POULTRY |
| 600 | 73 | 1710 | CORN-BELT | MONITORING ON FARM WASTE MANAGEMENT SYSTEMS KEYWORDS MONITORING FARM-WASTES MANAGEMENT |
| 600 | 71 | 1715 | CORN-BELT | THE STATE AND REGIONAL SITUATION KEYWORDS FEEDLOTS CONFINEMENT-PENS FARM-WASTES LIVES |
| 600 | 74 | 1744 | CORN-BELT | FIELD PERFORMANCE OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS KEYWORDS CATTLE WAS |
| 200 | 73 | 2473 | CORN-BELT | HYDROLOGY OF OPEN FEEDLOTS IN THE CORNBELT KEYWORDS HYDROLOGY FEEDLOTS CORN-BELT RAINF |
| 100 | 61 | 2505 | CORN-COBS | THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI |
| 100 | 75 | 2419 | CORN-FORAGE | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 200 | 74 | 1991 | CORN-PRODUCTION | EFFECT OF THE APPLICATION OF BEEF CATTLE FEEDLOT MANURE ON CORN PRODUCTION KEYWORDS |
| 300 | 72 | 2370 | CORN-SILAGE | COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS |
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100 72 1621  CCSTS      SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW  KFYWORDS  FEEDLOTS ODOR-
400 74 1626  CCSTS      MANURE HANDLING SYSTEMS FOR THE FUTURE  KEYWORDS  MANURE WASTE-HANDLING RECYCLING LAGOO
300 72 1628  CCSTS      NEBRASKA ANIMAL WASTE RESEARCH  KEYWCRDS  ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS
30C 74 1629  COSTS      CONTROL OF DUST FRCP CATTLE FEEDLCTS  KEYWORDS  CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN
30C 73 1640  CCSTS      IRRIGATION FCR LAND APPLICATICN OF ANIMAL WASTE  KEYWORDS ANIMAL-WASTES IRRIGATION LAND
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300    1829  DESIGN             THE TREATMENT OF MANURE IN OXIDATION DITCHES  KEYWORDS WASTE-TREATMENT MANURE OXIDATION
300 73 1835  DESIGN             STRUCTURES AND ENVIRONMENT HANDBOOK  KEYWORDS  PLANNING ENVIRONMENT WASTE-DISPOSAL DESI
600 74 1847  DESIGN             CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION  KEYWORDS  LIQU
100 74 1855  DESIGN             A ROTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER  KEYWORDS  SOLID-WAST
600 72 1886  DESIGN             SLOTTED FLOOR COLD CONFINEMENT BEEF CATTLE HOUSING  KEYWORDS  CATTLE DESIGN PERFORMANCE
600 73 1892  DESIGN             IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI  KEY
100 74 1896  DESIGN             HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS  KEYWORDS  DES
300 73 1907  DESIGN             FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II
100 72 1913  DESIGN             EFFECT OF SLOTTED FLOORS ON AIR FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILD
400 74 1917  DESIGN             DO FLUMES REALLY WORK  KEYWORDS  FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES
400 71 1918  DESIGN             NEW PUMP NEW SYSTEM FOR LIQUID MANURE  KEYWORDS  LIQUID-WASTES COSTS DESIGN WASTE-STORA
400 72 1942  DESIGN             THAT INESCAPABLE BYPRODUCT  KEYWORDS  DESIGN FEEDLOTS COLORADO RUNOFF-CONTROL LAND-DISP
100 74 1951  DESIGN             EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE  KEYWORDS  MOISTURE-CO
600 72 1954  DESIGN             EXPERIENCES WITH OXIDATION DITCHES IN A PULLET GROWING HOUSE KEYWORDS  POULTRY DESIGN C
200 71 1974  DESIGN             A PROCEDURE FOR DESIGN OF A MANURE STACKING FACILITY KEYWORDS  DESIGN DAIRY-INDUSTRY AG
200 71 1977  DESIGN             UNIVERSITY OF WISCONSIN RESEARCH ON MANURE HANDLING  KEYWORDS  WISCONSIN RESEARCH-AND-D
200 71 1978  DESIGN             LARGE COMMERCIAL FEEDLOTS HOW WASTES ARE HANDLED IN THE WEST KEYWORDS  FEEDLOTS NEBRASK
400 74 1994  DESIGN             THIS PARLOR MAKES USE OF NEW IDEAS  KEYWORDS  DAIRY-INDUSTRY DESIGN MONTANA ODOR VENTIL
200 74 2004  DESIGN             A COMPLETE SYSTEM FOR COLLECTING HANDLING AIR DRYING AND MACHINE DEHYDRATION OF POULTRY
200 74 2016  DESIGN             THE HANDLING AND TREATMENT OF MINK WASTES BY LIQUID AERATION  KEYWORDS  MINK DESIGN ECO
200 74 2019  DESIGN             THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE
200 74 2027  DESIGN             OXIDATION DITCH SYSTEM ANALYSIS AND FIELD EVALUATION OF THE AEROB-A-JET  KEYWORDS  ANAL
100 73 2051  DESIGN             BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS  KEYWORDS  TERRACES FEEDLOTS DESIGN WA
300 71 2062  DESIGN             MANAGEMENT OF DAIRY CATTLE WASTES BY THE DEEP AERATED LAGOON AND IRRIGATION ONTO SOILS
100 74 2069  DESIGN             WINTER OPERATION OF A MODIFIED OPEN FRONT FINISHING HOUSE FOR SWINE  KEYWORDS  WINTER D
600 74 2072  DESIGN             PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS  KEYWORDS  FUELS ENERGY DESIGN PYR
600 72 2074  DESIGN             RECOVERING PROTEIN FROM ANIMAL WASTE  KEYWORDS  PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE
400 73 2103  DESIGN             SLAB VS SLAT-AN EXPERT S OPINION  KEYWORDS  CONFINEMENT-PENS WASTE-DISPOSAL DESIGN ARIZ
300 72 2105  DESIGN             LAGOONS FOR ANIMAL WASTE DISPOSAL  KEYWORDS  WASTE-DISPOSAL LAGOONS DESIGN LOADING LAGO
400 75 2107  DESIGN             FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED  KEYWORDS  DESIGN CONSTRUC
100 74 2108  DESIGN             NUTRIENT TRANSFORMATIONS IN A SWINE WASTE OXIDATION DITCH KEYWORDS  WASTE-TREATMENT PHO
600 73 2124  DESIGN             DESIGN AND OPERATION OF A FEEDLOT RUNOFF DISPOSAL SYSTEM-A  CASE STUDY  KEYWORDS  DESIG
200 74 2135  DESIGN             AGRICULTURAL WASTE CONFERENCE  KEYWORDS  ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC
200 74 2137  DESIGN             PLANNING AND DESIGNING WASTE STORAGE SYSTEMS  KEYWORDS DESIGN WASTE-STORAGE CONFINEMENT
200 63 2153  DESIGN             NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS  POULTRY WASTE-TREATME
200 63 2157  DESIGN             INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL  KEYWORDS  LAGOONS POULTRY WASTE-DISPOSAL OD
200 63 2158  DESIGN             DIGESTION OF FARM POULTRY WASTES  KEYWORDS  ANAEROBIC-DIGESTION POULTRY WASTE-TREATMENT
200 63 2160  DESIGN             DEHYDRATION AND INCINERATION OF POULTRY MANURE  KEYWORDS DEHYDRATION INCINERATION POULT
400 72 2167  DESIGN             PLANNING FEEDLOT WASTE DISPOSAL  KEYWORDS  PLANNING FEEDLOTS WASTE-DISPOSAL WASTE-STORA
600 69 2175  DESIGN             THE DESIGN AND OPERATION OF AN OPEN FRONT SLOTTED FLOOR BEEF CONFINEMENT BUILDING  KEYW
300 71 2196  DESIGN             FEEDLOT WASTE MANAGEMENT-WHY AND HOW  KEYWORDS  FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON
600 64 2201  DESIGN             HOW ARE LAGOONS WORKING ON HOG FARMS  KEYWORDS  LAGOONS DESIGN WASTE-DISPOSAL CONFINEME
300 72 2213  DESIGN             METHANE PRODUCTION FROM ANAEROBIC DIGESTION OF ANIMAL WASTES  KEYWORDS  METHANE ANIMAL-
100 73 2218  DESIGN             DESIGN OF SOLID MANURE STORAGE FOR DAIRY HERDS  KEYWORDS DESIGN WASTE-STORAGE SOLID-WAS
200 69 2221  DESIGN             WASTE CONTROL ALTERNATIVES  KEYWORDS  AGRICULTURAL-RUNOFF FEEDLOTS LAGOONS TOPOGRAPHY C
700 69 2227  DESIGN             DESIGN FOR BENEFICIAL USE OF FEEDLOT RUNOFF  KEYWORDS DESIGN AGRICULTURAL-RUNOFF FEEDLO
100 71 2241  DESIGN             THE PERFORMANCE OF AN EXPERIMENTAL HIGH RATE BIOLOGICAL FILTRATION TOWER WHEN TREATING
300 73 2243  DESIGN             CONFINEMENT LIVESTOCK FACILITIES WASTE MANAGEMENT CODE OF PRACTICE  KEYWORDS  CANADA AL
300 72 2260  DESIGN             BEEF CATTLE FEEDLOT WASTE MANAGEMENT RESEARCH IN THE GREAT  PLAINS  KEYWORDS  RESEARCH-
600 72 2262  DESIGN             PROPERTIES RELATED TO MATERIALS HANDLING  KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR
400 71 2276  DESIGN             THE FALLACY OF DEEP PITS FOR POULTRY HOUSES  KEYWORDS DESIGN VENTILATION NUTRIENTS COST
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| 200 | 68 | 2282 | DESIGN | THEORY AND PRACTICE OF ANAEROBIC DIGESTERS AND LAGOCNS KEYWORDS ANAEROBIC-DIGESTION LA |
| 700 | 68 | 2310 | DESIGN | A MODEL STUDY OF FLOW VELOCITIES IN AN OXIDATICN DITCH KEYWORDS MODEL-STUDIES DESIGN O |
| 100 | 71 | 2351 | DESIGN | EXPERIMENTAL FACILITIES FOR STUDIES CN BEEF HOUSING AND EQUIPMENT KEYWORDS CONFINEMEN |
| 400 | 72 | 2375 | DESIGN | MANAGING ANIMAL WASTE DISPOSAL SYSTEMS KEYWORDS LAGOONS DESIGN SPRINKLER-IRRIGATION C |
| 300 | 74 | 2428 | DESIGN | UNDERFLOOR VENTILATION FOR SLCTTED FLCOR SWINE BUILCINGS KEYWORDS VENTILATION DESIGN C |
| 200 | 73 | 2432 | DESIGN | LIVESTOCK WASTE MANAGEMENT CONFERENCE KEYWORDS LIVESTOCK ILLINOIS LEGAL-ASPECTS FEED |
| 200 | 73 | 2433 | DESIGN | STATUS OF THE ILLINCIS LIVESTOCK WASTE MANAGEMENT REGULATIONS KEYWORDS ILLINOIS LEGAL |
| 200 | 73 | 2435 | DESIGN | MANURE STORAGE TANKS FOR LIQUIDS KEYWORDS WASTE-STORAGE LIQUID-WASTES DESIGN MANURE-S |
| 200 | 73 | 2436 | DESIGN | MANURE HANDLING BY HYDRAULIC FLUSHING KEYWORUS CESIGN LIQUID-WASTES RECYCLING CONFINE |
| 200 | 73 | 2445 | DESIGN | MY WASTE HANDLING SYSTEM FOR DAIRY KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LIQUID-WASTE |
| 100 | 65 | 2450 | DESIGN | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION DESIGN HOGS TEMPERATUR |
| 200 | 74 | 2463 | DESIGN | BEEF IN CCNFINEMENT WORKSHOP KEYWORCS FEEDLOTS CONFINEMENT-PENS CATTLE LEGAL-ASPECTS |
| 200 | 74 | 2466 | DESIGN | HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE KEYWORDS CONFINEMENT-PENS DESIGN |
| 200 | 74 | 2470 | DESIGN | WASTE HANDLING AND LAGCCN MANAGEMENT KEYWORCS LAGCONS FEEDLOTS DESIGN CHEMICAL-PROPER |
| 200 | 73 | 2472 | DESIGN | MIDWEST LIVESTOCK WASTE MANAGEMENT CCNFERENCE KEYWCRDS FEEDLOTS HYDROLOGY DESIGN CONFI |
| 200 | 73 | 2475 | DESIGN | OUTDOOUR UNPAVED FEEDLOT MANAGEMENT KEYWORCS FEEDLOTS CESIGN AGRICULTURAL-RUNOFF DRAIN |
| 200 | 73 | 2476 | DESIGN | CONFINEMENT SYSTEMS AND MANURE MANAGEMENT-STATE OF THE ART KEYWORDS CONFINEMENT-PENS |
| 200 | 73 | 2480 | DESIGN | AEROBIC TREATMENT OF LIVESTOCK WASTES KEYWORDS AEROBIC-TREATMENT LIVESTOCK DESIGN ORG |
| 200 | 73 | 2482 | DESIGN | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWCRDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 200 | 73 | 2484 | DESIGN | RECIRCULATION EQUIPMENT DESIGN AND SELECTION KEYWORDS EQUIPMENT DESIGN HYDRAULIC-TRANS |
| 600 | 72 | 2489 | DESIGN | PLANNING CCNSIDERATICNS FOR CCNFINEMENT SWINE FACILITIES KEYWORDS CONFINEMENT-PENS PL |
| 300 | 73 | 2498 | DESIGN | SYNTHESIS GAS FROM FEEDLOT MANURE-A CONCEPTUAL CESIGN STUDY KEYWORDS DESIGN EQUIPMENT |
| 100 | 72 | 2500 | DESIGN | THE BIO GAS PLANT-GENERATING METHANE FROM ORGANIC WASTES KEYWORDS RECYCLING ORGANIC-WA |
| 400 | 73 | 2519 | DESIGN | KEEPING THE FEEDER IN BUSINESS KEYWCRDS NEBRASKA FEEDLOTS REGULATICN WATER-POLLUTION |
| 300 | 72 | 2533 | DESIGN | CAIRY WASTE STORAGE PONDS FOR SOIL PLANT RECYCLING KEYWORDS DAIRY-INDUSTRY WASTE-STOR |
| 600 | 75 | 2537 | DESIGN | MODEL TO PREDICT THE PERFORMANCE OF FEEDLOT CONTROL FACILITIES AT SPECIFIC OREGON LOCAT |
| 100 | 65 | 2542 | DESIGN | DEVELOPMENTS IN HOG MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS CLEANING DESIGN S |
| 100 | 72 | 2550 | DESIGN | TREATMENT OF DAIRY WASTES BY MECHANISED BIOLCGICAL METHODS KEYWORDS WASTE-TREATMENT DA |
| 400 | 73 | 2552 | DESIGN | MOST PIG WASTE DISPOSAL SYSTEMS SATISFACTORY KEYWORDS LAGOONS DESIGN WASTE-DISPOSAL PU |
| 700 | 63 | 2553 | DESIGN | THE USE OF INDCOR LAGOONS FOR MANURE DISPOSAL IN HIGH CENSITY SYSTEMS OF POULTRY MANAGE |
| 600 | 73 | 2574 | DESIGN | METHODS AND PROBLEMS RELATING TO DISPOSAL OF WASTES FROM LIVESTOCK MARKETS KEYWORDS W |
| 100 | 73 | 2579 | DESIGN | MICROBIOLCGY IN THE AEROBIC TREATMENT OF FARM WASTES KEYWORDS MICROBIOLOGY AEROBIC-TRE |
| 200 | 75 | 2605 | DESIGN | MODIFICATIONS CF THE MICHIGAN STATE POULTRY IN-HOUSE DRYING SYSTEM KEYWORDS DESIGN MI |
| 200 | 75 | 2606 | DESIGN | DESIGN OF A POULTRY MANURE DRYING SYSTEM FOR A 155,000 LAYERS EGG FACTORY KEYWORDS DE |
| 200 | 75 | 2607 | DESIGN | IN-HOUSE MANURE DRYING-THE SLAT SYSTEM KEYWORDS CESIGN POULTRY DRYING ODOR VENTILATIO |
| 200 | 75 | 2608 | DESIGN | CONTROL COLLECTION AND CISPOSAL OF FEEDLOT RUNOFF KEYWORDS REGULATION ENGINEERING DES |
| 200 | 75 | 2610 | DESIGN | AN ILLINOIS FEEDLOT RUNCFF CONTROL PRCJECT KEYWORCS ILLINOIS FEFDLOTS CESIGN SPRINKLE |
| 200 | 75 | 2611 | DESIGN | FEEDLOT WASTE RECYCLING WITH A FLUSH CLEANING SYSTEM KEYWORDS FEEDLOTS WASTE-STORAGE W |
| 200 | 75 | 2612 | DESIGN | OPERATION OF A BEEF MANURE FLUSHING SYSTEM IN A COLD CLIMATE KEYWORDS CONFINEMENT-PENS |
| 200 | 75 | 2614 | DESIGN | EVALUATION CF DAIRY BEEF AND SWINE WASTE HANDLING SYSTEMS KEYWORDS LIVESTOCK DAIRY-IND |
| 200 | 75 | 2615 | DESIGN | LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES- EARTHEN BASINS KEYWORDS DAIRY- |
| 200 | 75 | 2618 | DESIGN | ADAPTATION OF A BRITISH WASTE MANAGEMENT SYSTEM TO THE US ENVIRONMENT KEYWORDS WASTE- |
| 200 | 75 | 2619 | DESIGN | A LIQUIC MANURE MANAGEMENT SYSTEM IN A TIE STALL DAIRY BARN KEYWORDS LIQUID-WASTES DA |
| 200 | 75 | 2625 | DESIGN | THE DAKOTA SYSTEM-A METHOD OF COLLECTING STORING ANC HANDLING ANIMAL WASTE KEYWORDS D |
| 200 | 75 | 2626 | DESIGN | MANURE PONDS FOR MINIMIZING POLLUTION KEYWORDS WISCONSIN DAIRY-INDUSTRY COSTS DESIGN |
| 200 | 75 | 2629 | DESIGN | EXPERIENCE WITH OPEN GUTTER FLUSH SYSTEMS FOR SWINE MANURE MANAGEMENT KEYWORDS CONFI |
| 200 | 75 | 2631 | DESIGN | SWINE WASTE NUTRIENT RECOVERY SYSTEM BASED ON THE USE OF THERMAL DISCHARGES KEYWORDS |
| 200 | 75 | 2634 | DESIGN | SIMPLIFYING MANURE HANDLING IN A SOLIC FLOOR SWINE HOUSING SYSTEM KEYWORDS DESIGN CO |
| 200 | 75 | 2635 | DESIGN | DOUBLE E FARMS-SWINE INSTALLATICN KEYWORDS DESIGN LAGOONS COSTS EQUIPMENT MAINTENANCE |
| 200 | 75 | 2636 | DESIGN | A WASTE MANAGEMENT SYSTEM FOR A 2500-HEAD SWINE OPERATION-A CASE STUDY KEYWORDS LIQUI |
| 200 | 75 | 2652 | DESIGN | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2656 | DESIGN | SMALL METHANE GENERATOR FOR WASTE DISPOSAL KEYWORDS METHANE RECYCLING DESIGN SWINE TAI |
| 200 | 75 | 2661 | DESIGN | DIRECT LAND DISPOSAL OF FEEDLCT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF NUTRIENTS LAND-DI |
| 200 | 75 | 2693 | DESIGN | EXHAUST SYSTEMS FOR UNDERFLCOR LIQUIC MANURE PITS KEYWORDS ODCR AIR-POLLUTION DESIGN |
| 200 | 75 | 2697 | DESIGN | MANAGEMENT OF ODORS ASSCCIATED WITH LIVESTOCK PRODUCTION KEYWORCS LIVESTOCK POULTRY EC |
| 200 | 75 | 2702 | DESIGN | AN ECCNOMIC AND MANAGERIAL EVALUATION OF MANURE FLUMING AND LANC APPLICATION SYSTEMS K |
| 200 | 75 | 2708 | DESIGN | MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES KEYWORDS IR |
| 200 | 75 | 2709 | DESIGN | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLCTS IN EASTERN NEBRASKA KEYWORDS AGRIC |
| 200 | 75 | 2710 | DESIGN | DESIGN RUNOFF VOLUME FRCM FEEDLCTS IN THE SOUTHWESTERN GREAT PLAINS KEYWORDS DESIGN A |
| 200 | 75 | 2718 | DESIGN | SETTLING CHARACTERISTICS OF SWINE MANURE AS RELATED TO DIGESTER LOADING KEYWORDS SEPA |
| 200 | 75 | 2719 | DESIGN | A ROTATING CONICAL SCREEN SEPARATOR FOR LIQUID-SOLIC SEPARATION OF BEEF WASTE KEYWORDS |
| 200 | 75 | 2724 | DESIGN | HIGH RATE MECHANIZED CCMPOSTING OF DAIRY MANURE KEYWORDS DESIGN MODEL-STUDIES COMPOSTI |
| 200 | 75 | 2725 | DESIGN | AEROBIC COMPCSTING-NEW BUILT-UP BED TECHNIQUE KEYWCRDS AEROBIC-CONDITIONS EQUIPMENT DE |
| 200 | 75 | 2733 | DESIGN | A DESIGN APPROACH FCR THE USE OF AN CXIDATION DITCH FOR LIVESTOCK WASTE TREATMENT KEYW |
| 200 | 75 | 2740 | DESIGN | BIOENGINEERING ASPECTS OF ANAEROBIC CIGESTION OF PIGGERY WASTES KEYWCRDS ANAEROBIC-DI |
| 200 | 75 | 2744 | DESIGN | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 200 | 75 | 2745 | DESIGN | SURFACE AERATION-DESIGN AN PERFORMANCE FOR LAGOONS KEYWORDS AERATION DESIGN PERFORMAN |
| 200 | 75 | 2753 | DESIGN | PLANT AND SOIL EFFECTS CF SWINE LAGOCN EFFLUENT APPLIED TO COASTAL BERMUDAGRASS KEYWO |
| 200 | 75 | 2755 | DESIGN | ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION KEYW |
| 200 | 75 | 2758 | DESIGN | AN OVERLAND FLOW-LAGCON RECYCLE SYSTEM AS A PRETREATMENT OF POULTRY WASTES KEYWORUS P |
| 200 | 71 | 1925 | DESIGN-CRITERIA | SOIL CONSERVATION SERVICE TEXAS TECH UNIVERSITY WORKSHOP COMMITTEE ON FEEDLOT WASTE KE |
| 200 | 71 | 1932 | DESIGN-CRITERIA | SOIL CONSERVATION SERVICE STANDARD AND SPECIFICATIONS FOR POLLUTION ABATEMENT MEASURES |
| 200 | 74 | 2023 | DESIGN-CRITERIA | A FUNDAMENTAL APPRCACH TO ANAEROBIC LAGCON ANALYSIS KEYWORDS MATHEMATICAL-MODELS ANAL |
| 700 | 73 | 2212 | DESIGN-CRITERIA | HYDROLOGY OF ANIMAL WASTE WATER PONDS KEYWORDS WASTE-WATER-POLLUTION PONDS HYDROLOGY |
| 700 | 74 | 2405 | DESIGN-CRITERIA | SOIL ABSORPTION OF HUMIC COLOR KEYWCRDS COLOR FEECLOTS ABSORPTICN CHEMICAL-OXYGEN-DEM |
| 200 | 73 | 2434 | DESIGN-CRITERIA | STORAGE STRUCTURES FOR SOLID MANURE KEYWORDS WASTE-STORAGE SCLID-WASTES SEPARATION-TE |
| 200 | 73 | 2438 | DESIGN-CRITERIA | DESIGN AND CONSTRUCTION OF HOLDING PONDS ANC LAGCONS KEYWORDS WASTE-DISPOSAL LAGOONS |
| 300 | 63 | 2471 | DESIGN-CRITERIA | MANURE DISPOSAL LAGCCNS KEYWORDS WASTE-DISPOSAL AEROBIC-CONDITIONS ANAEROBIC-CONDITIO |
| 200 | 73 | 2483 | DESIGN-CRITERIA | DESIGNING GUTTER FLUSHING SYSTEMS KEYWORDS DESIGN-CRITERIA HYDRAULIC-TRANSPORTATION M |
| 200 | 73 | 2487 | DESIGN-CRITERIA | RETURNING ANIMAL WASTES TO THE LAND-EQUIPMENT CCNSICERATIONS KEYWORDS EQUIPMENT DESIG |
| 600 | 71 | 2531 | DESIGN-CRITERIA | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEECLOTS DESIGN-CRITERIA MONTANA ENGINE |
| 600 | 75 | 2559 | DESIGN-CRITERIA | COMPARISON OF DESIGN CRITERIA AND PERFORMANCE OF WASTE HANDLING SYSTEMS KEYWORDS DESI |
| 100 | 63 | 2581 | DESIGN-CRITERIA | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 200 | 75 | 2655 | DESIGN-CRITERIA | START UP OF PILOT SCALE SWINE MANURE DIGESTERS FOR METHANE KEYWORDS RESEARCH-AND-DEVE |
| 200 | 75 | 2731 | DESIGN-CRITERIA | OXIDATION DITCHES FOR LIVESTOCK WASTES KEYWORDS LIVESTOCK AEROBIC-TREATMENT DESIGN-CR |
| 200 | 75 | 2735 | DESIGN-CRITERIA | AN EVALUATION OF AERATION SYSTEMS FOR POULTRY WASTES UNDER COMMERCIAL CONDITIONS KEYWO |
| 200 | 75 | 2736 | DESIGN-CRITERIA | TURBINE AIR AERATION SYSTEM FOR POULTRY WASTES KEYWORDS POULTRY COSTS TURBINE-AIR-AERA |
| 200 | 75 | 2743 | DESIGN-CRITERIA | BIOLOGICALLY-CONTROLLED LOADING OF AEROBIC STABILIZATION PLANTS KEYWORDS DESIGN-CRITE |
| 200 | 75 | 2746 | DESIGN-CRITERIA | TREATMENT OF LIVESTOCK WASTES BY BARRIERED LANDSCAPE WATER RENOVATION SYSTEM KEYWORDS |
| 600 | 72 | 1953 | DESIGN-DATA | A MECHANIZED COMPOST CHANNEL FOR ANIMAL WASTE KEYWCRDS DESIGN-DATA MECHANIZED-COMPOST- |
| 200 | 74 | 2152 | DESIGN-DATA | HANDLING DEHYDRATION AND UTILIZATION OF POULTRY WASTE KEYWORDS DEHYDRATION POULTRY REC |
| 300 | 74 | 2428 | DESIGN-FORMULA | UNDERFLOOR VENTILATION FOR SLOTTED FLCOR SWINE BUILDINGS KEYWORDS VENTILATION DESIGN C |
| 700 | 67 | 1877 | DESIGN-PROCEDURES | AN EXPERIMENTAL ANALYSIS OF STRAIN AND DEFLECTION IN GRIDWORK PANFLS FOR FLOOR SYSTEMS |
| 300 | 73 | 1851 | DESORPTION | ODORS FROM LIVESTOCK PRODUCTION KEYWCRDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 400 | 75 | 2071 | DES | DUNG HO-FDA SETS REGS ON RECYCLED FEED KEYWORDS REGULATION RECYCLING ANIMAL-WASTES FE |
| 100 | 66 | 2513 | DETECTION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTICN ADSORPTION CHEMICAL-REACTION D |
| 100 | 63 | 2581 | DETENTION-PERIOD | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 300 | 71 | 2523 | DETENTION-PONDS | FEEDLOT WASTE DISPOSAL AND WATER POLLUTION KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF WATE |
| 300 | 69 | 2797 | DETENTION-PONDS | MANAGEMENT AND CONTROL OF BEEF FEEDLOT WASTE KEYWORDS FEEDLOTS CATTLE NEBRASKA REGULAT |

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| 200 | 69 | 2221 | DETENTION-POND | WASTE CONTROL ALTERNATIVES KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS LAGOONS TOPOGRAPHY C |
| 200 | 75 | 2768 | DETENTION-POND | MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES KEYWORDS IR |
| 700 | 65 | 2128 | DETENTION-TIME | ANAEROBIC DIGESTION OF CHICKEN MANURE KEYWORDS ANAEROBIC-DIGESTION POULTRY MATHEMATIC |
| 700 | 73 | 2563 | DETRIMENTAL-EFFECT | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO A FORAGE SORGHUM KEYWORDS AGRICULTUR |
| 100 | 73 | 1801 | DEVELOPMENT | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE K |
| 300 | 72 | 2260 | DEVELOPMENT | BEEF CATTLE FEEDLOT WASTE MANAGEMENT RESEARCH IN THE GREAT PLAINS KEYWORDS RESEARCH- |
| 600 | 73 | 1623 | DEWATERING | DEWATERING BOVINE ANIMAL MANURE KEYWORDS DEWATERING CATTLE MANURE SLURRIES IRRIGATION |
| 400 | 74 | 2114 | DEWATERING | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 100 | 71 | 2241 | DEWATERING | THE PERFORMANCE OF AN EXPERIMENTAL HIGH RATE BIOLOGICAL FILTRATION TOWER WHEN TREATING |
| 700 | 72 | 2316 | DEWATERING | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 200 | 75 | 2639 | DEWATERING | A PIG SLURRY TREATMENT SYSTEM BASED ON SEPARATION BEFORE AEROBIC TREATMENT AND SLUDGE D |
| 700 | 72 | 2401 | DIAMETER | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY EQUAT |
| 100 | 69 | 2808 | DIENESTROL-TREATED | ABORTION IN CATTLE ASSOCIATED WITH THE FEEDING OF POULTRY LITTER KEYWORDS LITTER CATT |
| 700 | 72 | 2321 | DIETHYL-SULFIDE | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 200 | 75 | 2690 | DIETHYL-SULFIDE | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR MEA |
| 100 | 73 | 1747 | DIETS | FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS KEYWORDS DIETS POULTRY PROTEINS |
| 400 | 74 | 1772 | DIETS | DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS POULTRY FEEDS DIET |
| 400 | 74 | 1861 | DIETS | INCLUSION OF DRIED POULTRY WASTE AS A FEED INGREDIENT IN CATFISH RATIONS KEYWORDS CAT |
| 300 | 73 | 1874 | DIETS | RECYCLING ANIMAL WASTES AS PROTEIN SOURCES KEYWORDS RECYCLING ANIMAL-WASTES PROTEINS R |
| 200 | 74 | 2018 | DIETS | BEEF FEEDLOT WASTE IN RATIONS FOR BEEF CATTLE KEYWORDS CATTLE DIETS PERFORMANCE REFEED |
| 200 | 74 | 2019 | DIETS | THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE |
| 400 | 75 | 2038 | DIETS | POULTRY WASTE FOR CATFISH KEYWORDS CATFISHES DIETS PERFORMANCE PROTEINS POULTRY-WASTE |
| 700 | 67 | 2234 | DIETS | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 400 | 75 | 2350 | DIETS | CATFISH ON DPW KEYWORDS CATFISHES DIETS PERFORMANCE TASTE COSTS DRIED-POULTRY-WASTE |
| 300 | 72 | 2370 | DIETS | COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS |
| 100 | 75 | 2427 | DIETS | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 100 | 73 | 2431 | DIETS | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 100 | 75 | 2536 | DIETS | EFFECTS OF RECYCLING DRIED POULTRY WASTE ON YOUNG CHICKS KEYWORDS DIETS POULTRY PERFOR |
| 400 | 72 | 2538 | DIETS | FRESH WASTES HAVE MORE NUTRIENTS KEYWORDS POULTRY PERFORMANCE DIETS PROTEINS NUTRIENT |
| 200 | 75 | 2650 | DIETS | THE INCLUSION OF PIG MANURE IN RUMINANT DIETS KEYWORDS DIETS CATTLE CHEMICAL-PROPERTIE |
| 200 | 75 | 2685 | DIETS | EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TO VARIATIONS IN CONCENTRATIONS OF SOD |
| 200 | 73 | 1789 | DIET | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
| 100 | 74 | 2209 | DIFFUSE-SOURCES | AGRICULTURAL WASTE MANAGEMENT KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL REGULATION WATE |
| 100 | 72 | 2170 | DIFFUSION | DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION KEYWORD |
| 700 | 72 | 2321 | DIFFUSION | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 100 | 71 | 1936 | DIFFUSIVITY | TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM MEASUREMENT OF DIFFUSIVITY IN CATTLE |
| 400 | 74 | 1676 | DIGESTER | ORGANIC FERTILIZER OFFSHOOT OF POLLUTION FREE FEEDLOT KEYWORDS FERTILIZERS POLLUTION |
| 200 | 74 | 1868 | DIGESTER | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 200 | 74 | 2462 | DIGESTER | PRODUCTION OF METHANE FROM POULTRY MANURE KEYWORDS METHANE RESEARCH-AND-DEVELOPMENT C |
| 100 | 73 | 1637 | DIGESTIBILITY | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 700 | 69 | 1734 | DIGESTIBILITY | DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE KEYWORDS FEEDS RECYCLING WASTELAGE DIGEST |
| 300 | 73 | 1856 | DIGESTIBILITY | RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES KEYWORDS RUMINAN |
| 400 | 71 | 1935 | DIGESTIBILITY | BARN WASTES FOR FEED KEYWORDS FEEDS RUMINANTS BARN-WASTES REFEEDING DIGESTIBILITY CHE |
| 100 | 74 | 1950 | DIGESTIBILITY | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORD |
| 200 | 74 | 2014 | DIGESTIBILITY | INFLUENCE ON FEEDING SYSTEM DIGESTIBILITY OF RATION AND PROPORTION OF CONCENTRATE CONSU |
| 400 | 73 | 2115 | DIGESTIBILITY | ENZYMES DIGEST FIBER IN RECYCLED MANURE KEYWORDS RECYCLING POULTRY ENZYMES HEAT REFEE |
| 300 | 74 | 2219 | DIGESTIBILITY | DIGESTIBILITY OF CATTLE FEEDLOT WASTE KEYWORDS ANIMAL-WASTES CATTLE FEEDLOTS RATIONS |
| 400 | 73 | 2287 | DIGESTIBILITY | DIGESTIBILITY OF PROCESSED FEEDLOT MANURE KEYWORDS FEEDS CATTLE SHEEP PROTEINS PERFO |
| 300 | 74 | 2526 | DIGESTIBILITY | COMPOSITION AND DIGESTIBILITY OF CATTLE FECAL WASTE KEYWORDS CATTLE CHEMICAL-PROPERTI |
| 200 | 75 | 2648 | DIGESTIBILITY | NUTRITIONAL VALUE OF CATTLE FEEDLOT WASTE FOR GROWING- FINISHING BEEF CATTLE KEYWORDS |
| 200 | 75 | 2650 | DIGESTIBILITY | THE INCLUSION OF PIG MANURE IN RUMINANT DIETS KEYWORDS DIETS CATTLE CHEMICAL-PROPERTIE |
| 300 | 68 | 1625 | DIGESTION | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 100 | 73 | 1755 | DIGESTION | AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES KEYWORDS SAMPLING SOILS NI |
| 400 | 73 | 1768 | DIGESTION | IS TOTAL RECYCLING OF HEN MANURE POSSIBLE KEYWORDS POULTRY RECYCLING FERMENTATION DIG |
| 300 | 73 | 2053 | DIGESTION | SWINE WASTE AS NUTRIENT SOURCE FOR FINISHING PIGS KEYWORDS FEEDS NUTRIENTS PERFORMANC |
| 100 | 74 | 2189 | DIGESTION | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 700 | 67 | 2234 | DIGESTION | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 200 | 69 | 1760 | DIGESTION-TANK | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 600 | 74 | 2119 | DIGESTIVE-DEODORAN | CHEMICAL CONTROL OF MANURE ODOR KEYWORDS ODOR ENZYMES CHEMICAL-ODOR-CONTROL MANURE MA |
| 100 | 73 | 2249 | DILUTE-ACID-TRAPS | IDENTIFICATION OF ALIPHATIC AMINES VOLATILIZED FROM CATTLE FEEDYARD KEYWORDS FEEDLOT |
| 100 | 69 | 1659 | DILUTION | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 700 | 70 | 1680 | DILUTION | EFFECT OF FEEDLOT LAGOON WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED KAN |
| 700 | 71 | 1689 | DILUTION | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 100 | 71 | 1904 | DILUTION | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 600 | 72 | 2262 | DILUTION | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR |
| 100 | 73 | 2332 | DILUTION | ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS KEYWORD |
| 200 | 75 | 2680 | DILUTION-PLATE-TEC | A MYCOLOGICAL INVESTIGATION OF BEEF FEEDLOT MANURE IN A SEMIARID TEMPERATE CLIMATE KEY |
| 700 | 69 | 1656 | DIMENSIONAL-ANALYS | MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF KEYWORDS MATHEMATI |
| 600 | 64 | 2204 | DIMENSIONAL-ANALYS | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 100 | 74 | 2449 | DIMENSIONAL-ANALYS | ENHANCED TREATMENT OF LIVESTOCK WASTEWATER I SOLID LIQUID SEPARATION-ESTIMATION OF VIBR |
| 700 | 72 | 2321 | DIMETHYL-SULFIDE | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 200 | 75 | 2690 | DIMETHYL-SULFIDE | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR MEA |
| 400 | 69 | 1924 | DIPTERA | BIOLOGICAL DIGESTION OF MANURE BY DIPTERA KEYWORDS MANURE DIPTERA BIOLOGICAL-DIGESTIO |
| 100 | 72 | 2759 | DISADVANTAGESBISHO | HIGH RISE POULTRY HOUSES KEYWORDS ECONOMICS ODOR HIGH-RISE-POUTRY-HOUSES NEW-ZEALAND |
| 200 | 74 | 2142 | DISCHARGES | NPDES PERMIT SYSTEM AND GUIDELINES FOR MICHIGAN PRESENTED AT THE AGRICULTURAL WASTE CON |
| 400 | 74 | 2773 | DISCHARGES | THE EDITORS NOTEBOOK-ABOUT DISCHARGE REGULATIONS KEYWORDS CATFISHES RUNOFF PERMITS EN |
| 300 | 72 | 2089 | DISCHARGE | ANIMAL WASTE-REGULATORY CONSIDERATIONS KEYWORDS WATER-POLLUTION REGULATION FEEDLOTS P |
| 300 | 72 | 2090 | DISCHARGE-WATER | EUTROPHICATION IN THE GREAT PLAINS KEYWORDS EUTROPHICATION GREAT-PLAINS WATER-POLLUTI |
| 200 | 64 | 1703 | DISEASES | HEALTH ASPECTS OF POULTRY WASTE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL PUBLIC-HEALTH |
| 200 | 69 | 1824 | DISEASES | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
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| 100 | 72 | 2789 | DISEASES | EFFLUENT SPRAY DISEASE RISK KEYWORDS HEALTH DISEASES SALMONELLA SPRAY-IRRIGATION CATT |
| 600 | 71 | 1725 | DISEASE | ANIMAL WASTE REUSE KEYWORDS RECYCLING FEEDS POULTRY CATTLE PROTEINS INSECTICIDES COST |
| 200 | 75 | 2651 | DISEASE | A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION |
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| 400 | 74 | 2041 | DISEASE-PREVENTION | THE MANY ASPECTS OF SANITATION IN POULTRY DISEASE CONTROL KEYWORDS ENVIRONMENTAL-SANIT |
| 100 | 64 | 2079 | DISINFECTANTS | ODOR CONTROL IN CATTLE FEED YARDS KEYWORDS ODOR MECHANICAL-CONTROL LEGAL-ASPECTS SPRA |
| 100 | 73 | 1828 | DISINFECTION | THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID |
| 300 | 66 | 1897 | DISINFECTION | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION KEYWORDS POULTRY CHE |
| 400 | 74 | 2041 | DISINFECTION | THE MANY ASPECTS OF SANITATION IN POULTRY DISEASE CONTROL KEYWORDS ENVIRONMENTAL-SANIT |
| 300 | 48 | 2414 | DISINFECTION | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION KEYWORDS POULTRY FARM- |
| 100 | 69 | 1659 | DISPERSION | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 100 | 73 | 1793 | DISPERSION | DISPERSION DURING FLOW IN POROUS MEDIA WITH BILINEAR ABSORPTION KEYWORDS DISPERSION F |
| 700 | 74 | 2362 | DISPERSION | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 600 | 74 | 1671 | DISPOSAL | PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS KEYWORDS FEEDLOTS AGRICULT |
| 100 | 74 | 1857 | DISPOSAL | LOW COST DISPOSAL SYSTEMS FOR FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS DIS |
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400 73 1811  DRAINAGE            AVERT RUNOFF POLLUTION  KEYWORDS  AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P
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200 75 2695  DRIED-BACTERIA-CUL  THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WAST
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300 74 2177  DRIED-LAYER-WASTE   RECYCLING POULTRY WASTE AS FEED WILL IT PAY  KEYWORDS RECYCLING FEEDS ECONOMICS INCINER
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200 72 1645  DROPPINGS           ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING  KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC
300 73 1620  DROPPING-BOARDS     PROTO YPE OF A BROILER CAGE SYSTEM  KEYWORDS  BROILERS PERFORMANCE CAGE-SYSTEM CROSS-AU
400 73 1858  DRUGS               FERMENTATION HEADS FOR HIGHER PRODUCTIVITY  KEYWORDS FERMENTATION RECYCLING WASTE-TREAT
300 74 2527  DRUGS               FERMENTATION OF ENSILED BROILER LITTER  KEYWORDS  FERMENTATION LITTER PATHOGENS DRYING
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400 74 1827  DRYING              THIN BED DRYING OF POULTRY MANURE  KEYWORDS  MANURE DRYING  POULTRY CALIFORNIA ODOR AER
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600 73 2052  DRYING              CONSTANT RATE DRYING OF CHICKEN EXCRETA  KEYWORDS POULTRY DRYING EXCRETA DRYING-RATES
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| 300 | 72 | 1620 | EFFLUENT | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 400 | 73 | 1638 | EFFLUENT | EPA PREPARING TO RAILROAD THROUGH NEW POLLUTION RULES COVERING CATTLE FEEDLOTS KEYWORD |
| 400 | 71 | 1641 | EFFLUENT | TEST SWINE WASTE DISPOSAL SYSTEMS KEYWORDS SWINE WASTE-DISPOSAL TESTING WATER-POLLUTI |
| 200 | 66 | 1644 | EFFLUENT | TREATMENT OF ANIMAL WASTES AT THE GREENFIELD LABORATORIES OF ELI LILLY AND COMPANY KEY |
| 700 | 67 | 1651 | EFFLUENT | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 700 | 73 | 1652 | EFFLUENT | DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS WASTE-TREATMENT AGR |
| 700 | 66 | 1679 | EFFLUENT | TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS WAST |
| 100 | 73 | 1685 | EFFLUENT | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 700 | 69 | 1708 | EFFLUENT | SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT KEYWORDS SOILS P |
| 400 | 73 | 1740 | EFFLUENT | RUNOFF CONTROL SYSTEMS FOR CONCRETE DAIRY CATTLE YARDS KEYWORDS CATTLE DAIRY-INDUSTRY |
| 600 | 74 | 1749 | EFFLUENT | A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH PONDS KEYWORDS EFFLUENT F |
| 600 | 73 | 1754 | EFFLUENT | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING KEYWORDS FEEDLOTS AGRICULTUR |
| 200 | 69 | 1760 | EFFLUENT | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 300 | 74 | 1782 | EFFLUENT | POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS KEYWORDS FISH-FARMING |
| 700 | 71 | 1791 | EFFLUENT | PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM KE |
| 300 | 71 | 1866 | EFFLUENT | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 400 | 71 | 1898 | EFFLUENT | ANIMAL WASTE DISPOSAL KEYWORDS ANIMAL-WASTES WASTE-DISPOSAL CANADA AEROBIC-TREATMENT |
| 200 | 72 | 1908 | EFFLUENT | A STATUS REPORT ON AGRICULTURAL AND MUNICIPAL WASTE TREATMENT LAGOONS IN MISSISSIPPI K |
| 100 | 71 | 1910 | EFFLUENT | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 200 | 74 | 1996 | EFFLUENT | PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE KEYWORDS REGULATION LEGAL-ASPECTS WAST |
| 200 | 74 | 1998 | EFFLUENT | EFFLUENT REGULATIONS FOR LIVESTOCK AND POULTRY FEEDLOTS KEYWORDS ECONOMICS LEGAL-ASPEC |
| 200 | 74 | 2000 | EFFLUENT | IMPLICATIONS OF EFFLUENT GUIDELINES AND OTHER POLLUTION CONTROL MEASURES ON DAIRY FARMS |
| 200 | 74 | 2024 | EFFLUENT | TREATMENT OF BEEF WASTE BY A ROTATING BIOLOGICAL CONTACTOR KEYWORDS AEROBIC-TREATMENT |
| 200 | 74 | 2031 | EFFLUENT | EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFFLUENT ON CORN AND GRAIN SORGHUM KEYWORDS |
| 100 | 73 | 2051 | EFFLUENT | BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS KEYWORDS TERRACES FEEDLOTS DESIGN WA |
| 300 | 72 | 2090 | EFFLUENT | EUTROPHICATION IN THE GREAT PLAINS KEYWORDS EUTROPHICATION GREAT-PLAINS WATER-POLLUTI |
| 300 | 74 | 2100 | EFFLUENT | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 100 | 73 | 2111 | EFFLUENT | AGRICULTURAL RESEARCH CONCENTRATES ON FARM WASTE KEYWORDS FARM-WASTES EFFLUENT SLURRI |
| 100 | 72 | 2112 | EFFLUENT | SHORT CUTS FROM MUCK TO MEALS KEYWORDS FEEDS RECLAMATION EFFLUENT FISH ALGAE MOLLUSK |
| 100 | 74 | 2130 | EFFLUENT | EFFECT OF EFFLUENT FROM BEEF FEEDLOTS ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOIL |
| 400 | 74 | 2232 | EFFLUENT | EPA AND THE FISH FARMER KEYWORDS FISH-FARMING REGULATIONS EFFLUENT PONDS SUSPENDED-S |
| 700 | 63 | 2233 | EFFLUENT | CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE KEYWORDS FARM-WASTES HOGS ANAE |
| 100 | 75 | 2265 | EFFLUENT | SPRAY IRRIGATION OF DAIRY CATTLE MANURE EFFLUENT FOR MAXIMIZING CROP PRODUCTION KEYWOR |
| 600 | 74 | 2285 | EFFLUENT | POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS KEYWORDS POULTRY WAST |
| 700 | 69 | 2312 | EFFLUENT | FIELD TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS |
| 400 | 73 | 2364 | EFFLUENT | BIO GAS DISPOSAL SYSTEM NOT ON KEYWORDS METHANE COSTS ANAEROBIC-DIGESTION EFFLUENT NE |
| 100 | 75 | 2365 | EFFLUENT | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS EF |
| 700 | 73 | 2385 | EFFLUENT | PHYSICAL PROPERTIES OF A COLO SILTY CLAY LOAM SOIL DURING TWO YEARS IRRIGATION WITH EFF |
| 300 | 73 | 2407 | EFFLUENT | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS EFFLUE |
| 100 | 74 | 2491 | EFFLUENT | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY C |
| 700 | 73 | 2563 | EFFLUENT | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO A FORAGE SORGHUM KEYWORDS AGRICULTUR |
| 700 | 73 | 2584 | EFFLUENT | MINIMAL TREATMENT OF SWINE MANURE FOR IRRIGATION EFFECT ON NITROGEN KEYWORDS AEROBIC |
| 200 | 75 | 2597 | EFFLUENT | ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTION CONTROL RULES ON THE UNITED STATES |
| 200 | 75 | 2600 | EFFLUENT | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |

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| 200 | 75 | 2603 | EFFLUENT | THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION |
| 200 | 75 | 2616 | EFFLUENT | MILKING CENTER WASTE MANAGEMENT KEYWORDS DAIRY-INDUSTRY RECYCLING IRRIGATION EFFLUENT |
| 200 | 75 | 2700 | EFFLUENT | IF YOU CANNOT SPREAD IT TREAT IT KEYWORDS SLURRIES WASTE-TREATMENT SEPARATION-TECHNIQ |
| 200 | 75 | 2739 | EFFLUENT | A LAGOON GRASS TERRACE SYSTEM TO TREAT SWINE WASTE KEYWORDS WASTE-TREATMENT ANAEROBIC- |
| 200 | 75 | 2744 | EFFLUENT | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 200 | 75 | 2745 | EFFLUENT | SURFACE AERATION-DESIGN AN PERFORMANCE FOR LAGOONS KEYWORDS AERATION DESIGN PERFORMAN |
| 700 | 74 | 2774 | EFFLUENT | EFFECTS OF OVERLOADING SWINE EFFLUENT ON TALL FESCUE REED CANARYGRASS AND CORN KEYWORD |
| 100 | 74 | 1956 | EFFLUENT-DISPOSAL | DISPOSAL OF EFFLUENT FROM A BEEF CATTLE FEEDLOT RUNOFF CONTROL HOLDING POND KEYWORDS |
| 200 | 74 | 1999 | EFFLUENT-GUIDELINE | THE ECONOMIC IMPACTS OF IMPOSING EPA EFFLUENT GUIDELINES ON THE U S FED BEEF INDUSTRY |
| 200 | 74 | 2140 | EFFLUENT-GUIDELINE | ECONOMIC IMPACT OF SELECTED POLLUTION CONTROL MEASURES ON BEEF AND DAIRY FARMS KEYWORD |
| 200 | 74 | 2010 | EFFLUENT-TAXES | AN ECONOMIC ANALYSIS OF POLICIES TO CONTROL NUTRIENT AND SOIL LOSSES FROM A SMALL WATER |
| 400 | | 2191 | EGGMEN | HOW EGGMEN ARE SOLVING THE ECOLOGY PROBLEM KEYWORDS POULTRY ECOLOGY WASTE-STORAGE WAS |
| 200 | 68 | 1642 | EGG-LAYING-HOUSE | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 600 | 74 | 1916 | EGG-PRODUCTION | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY REFEEDING |
| 200 | 74 | 2006 | EGG-PRODUCTION | CHARACTERIZATION OF WHITE LEGHORN MANURE KEYWORDS FEEDS MORTALITY MOISTURE-CONTENT WH |
| 100 | 75 | 2427 | EGG-PRODUCTION | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 200 | 75 | 2651 | EGG-PRODUCTION | A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION |
| 400 | 74 | 1771 | EGG-WEIGHT | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 300 | 73 | 2043 | ELECTRICAL-CONDUCT | GUIDELINES FOR LAND DISPOSAL OF FEEDLOT LAGOON WATER KEYWORDS FEEDLOTS LAGOONS KANSAS |
| 300 | 71 | 2133 | ELECTRICAL-CONDUCT | ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT-TECHNOLOGY AND ECONOMICS PHASE I KEYW |
| 100 | 74 | 2515 | ELECTRICAL-CONDUCT | PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE F |
| 100 | 71 | 2092 | ELECTRICAL-DISPOSA | FARM EFFLUENT-ELECTRICAL DISPOSAL METHODS KEYWORDS EFFLUENTS FARM-WASTES SUSPENDED-SOL |
| 400 | 74 | 1809 | ELECTRICITY | MANURE REFEEDING CUTS ODOR SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN KEYWORDS ELECTRIC |
| 600 | 73 | 1815 | ELECTRIC-HEAT | ELECTRICALLY MANAGING WASTE FROM CAGED LAYERS KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL |
| 300 | 74 | 1959 | ELECTRIC-POWER-IND | ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS RECYCLING ANIMAL- |
| 100 | 73 | 1832 | ELECTRODES | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 100 | 71 | 2092 | ELECTROLYTIC-FLOTA | FARM EFFLUENT-ELECTRICAL DISPOSAL METHODS KEYWORDS EFFLUENTS FARM-WASTES SUSPENDED-SOL |
| 200 | 66 | 1644 | ELI-LILLY-AND-COMP | TREATMENT OF ANIMAL WASTES AT THE GREENFIELD LABORATORIES OF ELI LILLY AND COMPANY KEY |
| 700 | 68 | 1826 | ENCLOSED-SWINE-PRU | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 100 | 73 | 1637 | ENERGY | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 400 | 74 | 1769 | ENERGY | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 400 | 74 | 1771 | ENERGY | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 400 | 74 | 1772 | ENERGY | DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS POULTRY FEEDS DIET |
| 400 | 73 | 1859 | ENERGY | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 300 | 73 | 1907 | ENERGY | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 400 | 71 | 1937 | ENERGY | WASTES MAY PROVIDE FUEL FOR HEATING KEYWORDS FUELS GASES ENERGY FEEDLOTS PYROLYSIS M |
| 200 | 74 | 2013 | ENERGY | ENERGY AND MONETARY COSTS FOR TWO BEEF CATTLE WASTE DISPOSAL SYSTEMS KEYWORDS ENERGY |
| 600 | 74 | 2050 | ENERGY | METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR KEYWORDS METHANE FEASIBILITY-S |
| 600 | 74 | 2072 | ENERGY | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 300 | 74 | 2100 | ENERGY | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 100 | 73 | 2176 | ENERGY | RECYCLING ENERGY AND AGRICULTURAL ECONOMICS KEYWORDS RECYCLING ECONOMICS AGRICULTURE E |
| 100 | 74 | 2207 | ENERGY | DIGESTION BY-PRODUCT MAY GIVE ANSWER TO ENERGY PROBLEM KEYWORDS ENERGY ANAEROBIC-DIGE |
| 400 | 73 | 2266 | ENERGY | VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY KEYWORDS FEEDS POULTRY ENERGY |
| 200 | 72 | 2279 | ENERGY | NUTRIENT RECYCLING-MODERN ENERGY MANAGEMENT KEYWORDS NUTRIENTS RECYCLING ENERGY INCINE |
| 300 | 72 | 2313 | ENERGY | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 72 | 2314 | ENERGY | FUEL FROM WASTES-A MINOR ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 400 | 75 | 2330 | ENERGY | BRITISH GROUP ENCOURAGING WASTE RECYCLING KEYWORDS RECYCLING FARM-WASTES GREAT-BRITAIN |
| 300 | 74 | 2331 | ENERGY | NUTRIENT AND ENERGY COMPOSITION OF BEEF CATTLE FEEDLOT WASTE FRACTIONS KEYWORDS NUTRI |
| 100 | 74 | 2337 | ENERGY | MANURE GETS REDISCOVERED KEYWORDS FEEDLOTS FERTILIZERS LIVESTOCK COSTS ENERGY NITRATE |
| 100 | 75 | 2410 | ENERGY | SOLIDS REDUCTION OF BEEF CATTLE WASTES IN A SEMIBATCH PROCESS OXIDATION DITCH KEYWORDS |
| 300 | 75 | 2426 | ENERGY | USE OF SLUDGE RELIEVES FERTILIZER SHORTAGE KEYWORDS RECYCLING ENERGY FERTILIZERS SLUDG |
| 200 | 74 | 2457 | ENERGY | PROCEEDINGS OF SYMPOSIUM ON THE CONVERSION OF POULTRY WASTE TO ENERGY FEED OR FERTILIZE |
| 100 | 65 | 2542 | ENERGY | DEVELOPMENTS IN HOG MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS CLEANING DESIGN S |
| 100 | 71 | 2551 | ENERGY | COMPARATIVE EVALUATION OF SOME TECHNIQUES USED IN DETERMINATIONS OF NITROGEN AND ENERGY |
| 200 | 75 | 2590 | ENERGY | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 200 | 75 | 2591 | ENERGY | AN ECONOMIC ANALYSIS OF METHANE GENERATION FEASIBILITY ON COMMERCIAL EGG FARMS KEYWORD |
| 200 | 75 | 2643 | ENERGY | RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED KEYWORDS AEROBIC-TREATMENT SLURR |
| 200 | 75 | 2652 | ENERGY | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2656 | ENERGY | SMALL METHANE GENERATOR FOR WASTE DISPOSAL KEYWORDS METHANE RECYCLING DESIGN SWINE TAI |
| 200 | 75 | 2658 | ENERGY | CHARACTERIZATION OF METHANE PRODUCTION FROM POULTRY MANURE KEYWORDS METHANE ANAEROBIC- |
| 200 | 75 | 2740 | ENERGY | BIOENGINEERING ASPECTS OF ANAEROBIC DIGESTION OF PIGGERY WASTES KEYWORDS ANAEROBIC-DI |
| 400 | 74 | 2776 | ENERGY | ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES KEYWORDS ENERGY FUE |
| 200 | 71 | 2785 | ENERGY | AGRICULTURAL WASTES-AN ENERGY RESOURCE OF THE SEVENTIES KEYWORDS RECYCLING ENERGY FUEL |
| 100 | 72 | 2800 | ENERGY | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 400 | 75 | 2814 | ENERGY | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 400 | 72 | 1836 | ENERGY-CONTENT | FEEDING POULTRY MANURE TO ANIMALS KEYWORDS FEEDS EXCRETA DEHYDRATED-POULTRY-WASTE SHE |
| 200 | 73 | 2548 | ENERGY-CONTENT | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUT |
| 200 | 75 | 2703 | ENERGY-EXPENSE-EVA | ENERGETICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS KEYWORDS RECYCLING COSTS LIQUID-WAS |
| 200 | 74 | 2004 | ENERGY-REQUIREMENT | A COMPLETE SYSTEM FOR COLLECTING HANDLING AIR DRYING AND MACHINE DEHYDRATION OF POULTRY |
| 400 | 73 | 2067 | ENERGY-VALUE | DRIED POULTRY MANURE UTILIZATION KEYWORDS RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO |
| 400 | 72 | 2211 | ENGINEERING | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING BA |
| 400 | 72 | 2211 | ENGINEERING | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING BA |
| 600 | 71 | 2531 | ENGINEERING | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEEDLOTS DESIGN-CRITERIA MONTANA ENGINE |
| 200 | 75 | 2608 | ENGINEERING | CONTROL COLLECTION AND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS REGULATION ENGINEERING DES |
| 400 | 73 | 2123 | ENGLAND | DPW FOR RUMINANTS GROWS IN ENGLAND KEYWORDS PROTEINS COSTS FEEDS DRIED-POULTRY-MANURE |
| 200 | 75 | 2639 | ENGLAND | A PIG SLURRY TREATMENT SYSTEM BASED ON SEPARATION BEFORE AEROBIC TREATMENT AND SLUDGE D |
| 300 | 73 | 1856 | ENSILED-ANIMAL-AND | RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES KEYWORDS RUMINAN |
| 100 | 75 | 2419 | ENSILED-BROILER-LI | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 300 | 74 | 2527 | ENSILING | FERMENTATION OF ENSILED BROILER LITTER KEYWORDS FERMENTATION LITTER PATHOGENS DRYING |
| 600 | 75 | 2546 | ENSILING | NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT KEYWORDS TECHNOLOGY NUTRIENTS NITROG |
| 200 | 75 | 2641 | ENSILING | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 200 | 75 | 2652 | ENSILING | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2654 | ENSILING | HEALTH ASPECTS OF FEEDING ANIMAL WASTE CONSERVED IN SILAGE KEYWORDS PERFORMANCE SALMON |
| 200 | 64 | 1697 | ENVIRONMENTAL-CONT | SOCIAL AND LEGAL IMPLICATIONS OF ORGANIC WASTE MANAGEMENT KEYWORDS ORGANIC-WASTES MANA |
| 600 | 71 | 1723 | ENVIRONMENTAL-CONT | SWINE SYSTEMS FOR IOWA AND NORTH CENTRAL STATES KEYWORDS SWINE WASTE-MANAGEMENT IOWA E |
| 100 | 72 | 1960 | ENVIRONMENTAL-CONT | COMPARISON OF SELECTED ENVIRONMENTAL CONDITIONS AND BEEF CATTLE PERFORMANCE IN POLE TYP |
| 200 | 74 | 2141 | ENVIRONMENTAL-CONT | MICHIGAN S ENVIRONMENTAL CONTROL PROGRAM AND ORGANIZATION KEYWORDS MICHIGAN WATER-POLL |
| 200 | 70 | 2399 | ENVIRONMENTAL-CONT | REPORT FROM NEW JERSEY KEYWORDS NEW JERSEY ENVIRONMENTAL-CONTROL WASTE-DISPOSAL POLLU |
| 100 | 71 | 2762 | ENVIRONMENTAL-CONT | MANURE HANDLING SYSTEMS AND ENVIRONMENTAL CONTROL FOR CONFINED DAIRY HOUSING KEYWORDS |
| 300 | 73 | 1733 | ENVIRONMENTAL-EFFE | THE ECONOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA KEYWORDS FEEDLOTS CATTLE ZONIN |
| 200 | 74 | 2003 | ENVIRONMENTAL-EFFE | AN ENVIRONMENTAL ANALYSIS OF FEEDLOT SYSTEMS KEYWORDS FEEDLOTS SYSTEMS-ANALYSIS ENVIRO |
| 200 | 71 | 2453 | ENVIRONMENTAL-EFFE | AGRICULTURAL WASTES IN ARID ZONES KEYWORDS AGRICULTURAL-WASTES DOMESTIC-WASTES WATER- |
| 600 | 75 | 2492 | ENVIRONMENTAL-EFFE | ANIMAL WASTE MANAGEMENT THROUGH CONTINUOUS SUBSURFACE INJECTION KEYWORDS WASTE-DISPOS |
| 100 | 73 | 2521 | ENVIRONMENTAL-EFFE | SOME EFFECTS OF FERTILIZERS AND FARMYARD MANURE ON THE ORGANIC PHOSPHORUS IN SOILS KEY |
| 400 | 72 | 2594 | ENVIRONMENTAL-EFFE | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 200 | 75 | 2655 | ENVIRONMENTAL-IMPA | START UP OF PILOT SCALE SWINE MANURE DIGESTERS FOR METHANE KEYWORDS RESEARCH-AND-DEVE |
| 400 | 73 | 1638 | ENVIRONMENTAL-PROT | EPA PREPARING TO RAILROAD THROUGH NEW POLLUTION RULES COVERING CATTLE FEEDLOTS KEYWORD |
| 600 | 71 | 1729 | ENVIRONMENTAL-PROT | EPA S ROLE IN THE ANIMAL WASTE PROBLEM-PANEL DISCUSSION KEYWORDS FARMS COSTS FEDERAL-G |
| 400 | 74 | 1781 | ENVIRONMENTAL-PROT | THEY RE GETTING THE JUMP ON POLLUTION CONTROLS KEYWORDS WATER-POLLUTION CONTROL CONFIN |
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300 75 2494 ENVIRONMENT        TREATMENT AND ULTIMATE DISPOSAL OF CATTLE FEEDLOT WASTES KEYWORDS  FEEDLOTS WASTE-TREAT
200 74 1988 ENZYMATIC-HYDROLYS MODIFICATION AND ENZYMATIC HYDROLYSIS OF CATTLE FEEDLOT MANURE  KEYWORDS  FEEDLOTS CATT
200 74 1071 ENZYMES            THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODORS AND DECOMPOSE ORGANIC W
400 73 2115 ENZYMES            ENZYMES DIGEST FIBER IN RECYCLED MANURE  KEYWORDS  RECYCLING POULTRY ENZYMES HEAT REFEE
600 74 2119 ENZYMES            CHEMICAL CONTROL OF MANURE ODOR  KEYWORDS  ODOR ENZYMES CHEMICAL-ODOR-CONTROL MANURE MA
200 75 2695 ENZYMES            THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WAST
700 68 1037 EQUATIONS          A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM A
600 68 1062 EQUATIONS          BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI
700 67 1077 EQUATIONS          AN EXPERIMENTAL ANALYSIS OF STRAIN AND DEFLECTION IN GRIDWORK PANELS FOR FLOOR SYSTEMS
600 74 1088 EQUATIONS          BEEF FEEDLOT MANURE AND SOIL WATER MOVEMENT  KEYWORDS  EQUATIONS MANURE WATER-INTAKE-RA
100 71 1910 EQUATIONS          SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM  KEYWORDS  SALTS RECYC
600 72 2073 EQUATIONS          DRYING PARAMETERS OF FORMED POULTRY EXCRETA  KEYWORDS DRYING POULTRY TEMPERATURE AIR EQ
200 75 2663 EQUATIONS          DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND  KEYWORDS FEEDLOTS CATTLE KANSAS CROP-RESPONS
200 75 2677 EQUATIONS          NITROGEN REMOVAL AND RECOVERY FROM POULTRY WASTEWATER BY ION EXCHANGE  KEYWORDS  POULTR
200 75 2734 EQUATIONS          A THEORETICAL DESCRIPTION OF AEROBIC TREATMENT  KEYWORDS AEROBIC-TREATMENT POULTRY MODE
200 75 2750 EQUATIONS          ON-THE-FARM DETERMINATION OF ANIMAL WASTE DISPOSAL RATES FOR CROP PRODUCTION  KEYWORDS
700 72 2770 EQUATIONS          DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA  KEYWORDS  POULTRY DRYIN
700 72 2401 EQUATION           DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA  KEYWORDS  POULTRY EQUAT
300 74 1629 EQUIPMENT          CONTROL OF DUST FROM CATTLE FEEDLOTS  KEYWORDS  CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN
300 73 1640 EQUIPMENT          IRRIGATION FOR LAND APPLICATION OF ANIMAL WASTE  KEYWORDS ANIMAL-WASTES IRRIGATION LAND
700 67 1651 EQUIPMENT          MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE  KEYWORDS
700 73 1652 EQUIPMENT          DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS  WASTE-TREATMENT AGR
700 65 1666 EQUIPMENT          PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH  KEYWORDS OXIDATION-DITCH PERFORMANCE
600 73 1682 EQUIPMENT          POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN  KEYWORDS  FAR
200 64 1691 EQUIPMENT          SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT  KEYWORDS  POULTRY EXCRE
200 64 1694 EQUIPMENT          ODORS AND THEIR CONTROL  KEYWORDS  ODOR CONTROL EQUIPMENT POULTRY EXCRETA FEATHERS ANAE
700 66 1707 EQUIPMENT          AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS  KEYWO
400 73 1741 EQUIPMENT          CHANGES WE VE MADE IN MANURE HANDLING  KEYWORDS  MANURE-HANDLING COSTS CATTLE DAIRY-IND
700 71 1742 EQUIPMENT          A COMPARISON OF AN AERATED LAGOON AND IRRIGATION SYSTEM WITH A CONVENTIONAL SYSTEM FOR
700 71 1762 EQUIPMENT          INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W
400 72 1804 EQUIPMENT          FEEDLOT DESIGN AND CONSTRUCTION  KEYWORDS  FEEDLOTS CONSTRUCTION DESIGN FACILITIES CATT
700 68 1826 EQUIPMENT          ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING  KEYWORDS  SWINE CONFI
100 73 1832 EQUIPMENT          DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING  THE AMMONIA ELECTRODE  KEYW
700 68 1037 EQUIPMENT          A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM A
300 70 1839 EQUIPMENT          ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL SYSTEMS FOR DAIRY CATTLE  KEYWORDS  LIQUI
300 74 1900 EQUIPMENT          CONVERSION OF CATTLE FEEDLOT WASTES TO AMMONIA SYNTHESIS GAS  KEYWORDS  CATTLE FEEDLOTS
400 72 1945 EQUIPMENT          THIS PLANT WILL CONVERT WASTE INTO PROTEIN  KEYWORDS  FEEDS PROTEINS THERMOPHILIC-BACTE
100 72 2059 EQUIPMENT          RECYCLING OF ORGANIC WASTES WITH PROCESSING SYSTEM THAT PRECISELY CONTROLS HEAT AND FLO
400 75 2116 EQUIPMENT          FEED PRICES ENVIRONMENTAL LAWS HELP SALES OUTLOOK FOR DRYING EQUIPMENT OPN  KEYWORDS  E
200 63 2160 EQUIPMENT          DEHYDRATION AND INCINERATION OF POULTRY MANURE  KEYWORDS DEHYDRATION INCINERATION POULT
600 67 2178 EQUIPMENT          MANURE SLURRY STORAGE PROCESSING AND PUMPING  KEYWORDS  WASTE-STORAGE PUMPING SLURRIES
400 73 2338 EQUIPMENT          FOR THE SAKE OF YOUR NEIGHBOURS SLURRY INJECTION  KEYWORDS  SLURRIES EQUIPMENT COSTS LA
100 71 2351 EQUIPMENT          EXPERIMENTAL FACILITIES FOR STUDIES ON BEEF HOUSING AND EQUIPMENT  KEYWORDS  CONFINEMEN
100 74 2430 EQUIPMENT          ODOR REDUCTION FOR LIQUID MANURE SYSTEMS  KEYWORDS  ODOR MEASUREMENT LIQUID-WASTES INJE
200 73 2437 EQUIPMENT          OXYGENATION AND FLOW CHARACTERISTICS OF MECHANICAL AERATORS KEYWORDS  AERATION OXYGENAT
200 73 2440 EQUIPMENT          REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE
200 73 2441 EQUIPMENT          SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT  FOR LIQUID MANURE DISPOSAL
200 73 2484 EQUIPMENT          RECIRCULATION EQUIPMENT DESIGN AND SELECTION  KEYWORDS EQUIPMENT DESIGN HYDRAULIC-TRANS
200 73 2487 EQUIPMENT          RETURNING ANIMAL WASTES TO THE LAND-EQUIPMENT CONSIDERATIONS  KEYWORDS  EQUIPMENT DESIG
600 75 2492 EQUIPMENT          ANIMAL WASTE MANAGEMENT THROUGH CONTINUOUS SUBSURFACE INJECTION  KEYWORDS  WASTE-DISPOS
300 73 2498 EQUIPMENT          SYNTHESIS GAS FROM FEEDLOT MANURE-A CONCEPTUAL DESIGN STUDY KEYWORDS  DESIGN EQUIPMENT
200 75 2615 EQUIPMENT          LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES- EARTHEN BASINS  KEYWORDS  DAIRY-
200 75 2626 EQUIPMENT          MANURE PONDS FOR MINIMIZING POLLUTION  KEYWORDS  WISCONSIN  DAIRY-INDUSTRY COSTS DESIGN
200 75 2635 EQUIPMENT          DOUBLE E FARMS-SWINE INSTALLATION  KEYWORDS  DESIGN LAGOONS COSTS EQUIPMENT MAINTENANCE
200 75 2714 EQUIPMENT          PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS  KEYWORDS  E
200 75 2715 EQUIPMENT          EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL  KEYWORDS
200 75 2716 EQUIPMENT          SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST DAIRY
200 75 2722 EQUIPMENT          DRYING OF POULTRY MANURE AN ECONOMIC AND TECHNICAL FEASIBILITY STUDY  KEYWORDS  ECONOMI
200 75 2725 EQUIPMENT          AEROBIC COMPOSTING-NEW BUILT-UP BED TECHNIQUE  KEYWORDS AEROBIC-CONDITIONS EQUIPMENT DE
200 75 2728 EQUIPMENT          LIQUID COMPOSTING OF DAIRY MANURE  KEYWORDS  LIQUID-WASTES  DAIRY-INDUSTRY CALIFORNIA E
200 75 2729 EQUIPMENT          LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES  KEYWORDS  LIQUID-WASTES EQUIPMENT AER
200 75 2740 EQUIPMENT          BIOENGINEERING ASPECTS OF ANAEROBIC DIGESTION OF PIGGERY WASTES  KEYWORDS  ANAEROBIC-DI
600 74 1949 ERODIBILITY-FACTOR ERODIBILITY FACTOR OF BEEF CATTLE MANURE  KEYWORDS  CATTLE  FEEDLOTS SOLID-WASTES WASTE
200 73 2440 ERODIBILITY-FACTOR REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE
200 74 2030 EROSION            CROP AND HAY LAND DISPOSAL AREAS FOR LIVESTOCK WASTES  KEYWORDS  CROP-RESPONSE AGRICULT
300 72 2104 EROSION            LAND DISPOSAL OF LIVESTOCK WASTE  KEYWORDS  WATER-POLLUTION LIVESTOCK LAGOONS EROSION A
100 72 2190 EROSION            AGRICULTURAL RUNOFF CHARACTERISTICS AND CONTROL  KEYWORDS AGRICULTURAL-RUNOFF CONTROL E
200 73 2441 EROSION            SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT  FOR LIQUID MANURE DISPOSAL
300 73 1915 EROSION-CONTROL    METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM  AGRICULTURAL NONPOINT SOURC
100 73 2051 EROSION-CONTROL    BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS  KEYWORDS  TERRACES FEEDLOTS DESIGN MA
400 75 2334 EROSION-CONTROL    ORGANIC WASTES-ONCE NUISANCES-NOW RESOURCES  KEYWORDS ORGANIC-WASTES FERTILIZERS SOIL-A
200 72 1645 ERS                ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING  KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC
300 74 1860 ESTIMATING         ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS  NUTRIENTS EUTROPH
100 69 2008 ESTROGENIC-ACTIVIT ABORTION IN CATTLE ASSOCIATED WITH THE FEEDING OF POULTRY LITTER  KEYWORDS  LITTER CATT
700 71 1864 ETHERS             KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR
100 74 2097 ETHER-EXTRACT      SIZE DISTRIBUTION AND NUTRITIONAL VALUE OF SWINE MANURE SEPARATES  KEYWORDS  NUTRIENTS
200 75 2646 ETHER-EXTRACT      MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE
200 75 2649 ETHER-EXTRACT      NUTRITIVE VALUE OF SWINE FECES FOR SWINE  KEYWORDS  NUTRIENTS REFEEDING SWINE ABSORBED-
300 71 2077 ETHYLENE           AIR POLLUTION AND AGRICULTURE  KEYWORDS  AGRICULTURE AIR-POLLUTION ARIZONA POLLUTANTS S
400 75 2501 ETHYLENE           MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS  KEYWORDS  RECYCLING BY-PRODUCTS FEED
200 74 2017 EUROPE             EUROPEAN APPROACHES TO THE CONTROL OF WATER POLLUTION PROBLEMS CAUSED BY AGRICULTURAL W
400 72 2298 EUROPE             DRIED POULTRY WASTE AS FEED  KEYWORDS  FEEDS DRYING COSTS PROTEINS ECONOMICS DRIED-POUL
400 75 2425 EUROPE             UTILIZING WASTES IN ANIMAL FEEDS-A EUROPEAN OVERVIEW  KEYWORDS  RECYCLING ORGANIC-WASTE
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|---|---|---|---|---|
| 300 | 74 | 1860 | EUTROPHICATION | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 600 | 70 | 1896 | EUTROPHICATION | WATER QUALITY AND WASTE DISPOSAL IN MONTANA KEYWORDS WATER-QUALITY WASTE-DISPOSAL MONT |
| 300 | 72 | 2090 | EUTROPHICATION | EUTROPHICATION IN THE GREAT PLAINS KEYWORDS EUTROPHICATION GREAT-PLAINS WATER-POLLUTI |
| 200 | 74 | 2141 | EUTROPHICATION | MICHIGAN S ENVIRONMENTAL CONTROL PROGRAM AND ORGANIZATION KEYWORDS MICHIGAN WATER-POLL |
| 300 | 74 | 2255 | EUTROPHICATION | ANIMAL WASTES AND FERTILIZERS AS POTENTIAL SOURCES OF NITRATE POLLUTION OF WATER KEYWO |
| 200 | 70 | 2393 | EUTROPHICATION | PLANT NUTRIENT BUDGETS AND WASTE DISPOSAL KEYWORDS NUTRIENTS WASTE-DISPOSAL NITROGEN |
| 200 | 70 | 2506 | EUTROPHICATION | AGRICULTURE AND NATURES NUTRIENT CYCLES KEYWORDS AGRICULTURE WATER-POLLUTION NITROGEN |
| 700 | 66 | 1707 | EVALUATION | AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS KEYWO |
| 600 | 73 | 1892 | EVALUATION | IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI KEY |
| 200 | 75 | 2623 | EVALUATION | A PLANNING STUDY ON DAIRY WASTES MANAGEMENT KEYWORDS DAIRY-INDUSTRY CALIFORNIA WATER-P |
| 100 | 74 | 2775 | EVALUATION | EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO |
| 200 | 74 | 1777 | EVAPORATION | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 300 | | 1792 | EVAPORATION | SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF |
| 400 | 73 | 1811 | EVAPORATION | AVERT RUNOFF POLLUTION KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P |
| 600 | 72 | 1992 | EVAPORATION | EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM KEYWORDS CLIMATOLOGY FEEDL |
| 700 | 73 | 2212 | EVAPORATION | HYDROLOGY OF ANIMAL WASTE WATER PONDS KEYWORDS WASTE-WATER-POLLUTION PONDS HYDROLOGY |
| 100 | 74 | 2252 | EVAPORATION | FEEDLOT WASTE EFFECTS ON SOIL CONDITIONS AND WATER EVAPORATION KEYWORDS FEEDLOTS EFFE |
| 200 | 73 | 2473 | EVAPORATION | HYDROLOGY OF OPEN FEEDLOTS IN THE CORNBELT KEYWORDS HYDROLOGY FEEDLOTS CORN-BELT RAINF |
| 200 | 75 | 2701 | EVAPORATION | EVAPORATION OF WATER FROM HOLDING PONDS KEYWORDS EVAPORATION PHYSICAL-PROPERTIES CHEM |
| 200 | 75 | 2640 | EVAPORATION-PONDS | OXIDATION DITCH WASTE MANAGEMENT SYSTEM FOR A LARGE CONFINEMENT SWINE FARM KEYWORDS O |
| 400 | 74 | 2114 | EVAPORATION-POND | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 100 | 70 | 2381 | EXCHANGEABLE-AMMON | COMPARISON OF INORGANIC NITROGEN CONTENTS OF UNDISTURBED CULTIVATED AND BARNYARD SOIL P |
| 100 | 72 | 1675 | EXCREMENT | NUTRITIVE VALUE OF AEROBICALLY SUSTAINED SWINE EXCREMENT KEYWORDS NUTRIENTS SWINE EXCR |
| 200 | 68 | 1642 | EXCRETA | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 200 | 68 | 1643 | EXCRETA | MICROBIOLOGICAL ASPECTS OF POULTRY WASTES KEYWORDS EXCRETA POULTRY MICROBIOLOGY NUTRIE |
| 300 | 72 | 1647 | EXCRETA | HOUSE FLY CONTROL IN CAGED LAYER HOUSES KEYWORDS LARVAE FLY-CONTROL CAGED-LAYERS-HOUS |
| 200 | 64 | 1691 | EXCRETA | SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS POULTRY EXCRE |
| 200 | 64 | 1692 | EXCRETA | WASTE DISPOSAL CONCEPTS KEYWORDS WASTE-DISPOSAL EXCRETA POULTRY LAGOONS ANAEROBIC-DIG |
| 200 | 64 | 1693 | EXCRETA | PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL-AEROBIC STABILI |
| 200 | 64 | 1694 | EXCRETA | ODOURS AND THEIR CONTROL KEYWORDS ODOR CONTROL EQUIPMENT POULTRY EXCRETA FEATHERS ANAE |
| 600 | 72 | 1709 | EXCRETA | NUTRIENT CHANGES IN POULTRY EXCRETA FERMENTED WITH RUMEN BACTERIA KEYWORDS NUTRIENTS |
| 100 | 65 | 1750 | EXCRETA | COMPARATIVE EFFECTIVENESS AND PERSISTENCE OF CERTAIN INSECTICIDES IN POULTRY DROPPINGS |
| 200 | 69 | 1760 | EXCRETA | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 400 | 72 | 1836 | EXCRETA | FEEDING POULTRY MANURE TO ANIMALS KEYWORDS FEEDS EXCRETA DEHYDRATED-POULTRY-WASTE SHE |
| 700 | 71 | 1864 | EXCRETA | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 200 | 74 | 1867 | EXCRETA | SURMOUNTING THE POULTRY WASTE PROBLEM KEYWORDS POULTRY EXCRETA WASTE-MANAGEMENT ANAER |
| 200 | 74 | 1870 | EXCRETA | EVALUATION OF POULTRY MANURE AS A FEED INGREDIENT KEYWORDS POULTRY EXCRETA DRIED-POULT |
| 400 | 74 | 1906 | EXCRETA | PROCESSED MANURE SEEN AS PROTEIN OF FUTURE KEYWORDS CATTLE REFEEDING EXCRETA PROTEINS |
| 100 | 71 | 1910 | EXCRETA | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 400 | 74 | 1911 | EXCRETA | A CLOSED SYSTEM NEW IDEA IN POULTRY WASTE DISPOSAL KEYWORDS POULTRY RECYCLING EXCRETA |
| 400 | 73 | 1922 | EXCRETA | KAOLIN RESULTS IN DRIER DROPPINGS KEYWORDS POULTRY ADDITIVES EXCRETA KAOLIN FLY-CONTR |
| 200 | 69 | 1983 | EXCRETA | USE OF POULTRY MANURE AND LITTER IN CROP PRODUCTION KEYWORDS CROP-PRODUCTION FERTILIZ |
| 200 | 74 | 2004 | EXCRETA | A COMPLETE SYSTEM FOR COLLECTING HANDLING AIR DRYING AND MACHINE DEHYDRATION OF POULTRY |
| 200 | 74 | 2005 | EXCRETA | INTEGRATED POULTRY MANURE HANDLING USING FLUSH TRAYS UNDER CAGES AND RENOVATED WASTEWA |
| 200 | 74 | 2014 | EXCRETA | INFLUENCE OF FEEDING SYSTEM DIGESTIBILITY OF RATION AND PROPORTION OF CONCENTRATE CONSU |
| 400 | 75 | 2040 | EXCRETA | PROCESSED EXCRETA POTENTIALLY NUTRITIONAL KEYWORDS CATTLE FEEDS PROTEINS RECYCLING PE |
| 600 | 73 | 2052 | EXCRETA | CONSTANT RATE DRYING OF CHICKEN EXCRETA KEYWORDS POULTRY DRYING EXCRETA DRYING-RATES |
| 600 | 72 | 2073 | EXCRETA | DRYING PARAMETERS OF FORMED POULTRY EXCRETA KEYWORDS DRYING POULTRY TEMPERATURE AIR EQ |
| 100 | 73 | 2134 | EXCRETA | DRYING CHARACTERISTICS OF FORMED POULTRY EXCRETA KEYWORDS POULTRY DRYING PHYSICAL-PRO |
| 200 | 74 | 2152 | EXCRETA | HANDLING DEHYDRATION AND UTILIZATION OF POULTRY WASTE KEYWORDS DEHYDRATION POULTRY REC |
| 200 | 63 | 2155 | EXCRETA | FOWL FECAL FACTS KEYWORDS POULTRY PHYSICAL-PROPERTIES CHEMICAL-PROPERTIES BIOCHEMICAL |
| 100 | 74 | 2236 | EXCRETA | USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL |
| 100 | 75 | 2272 | EXCRETA | MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE KEYWORDS POULTR |
| 700 | 72 | 2401 | EXCRETA | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY EQUAT |
| 100 | 73 | 2431 | EXCRETA | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 700 | 72 | 2770 | EXCRETA | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY DRYIN |
| 400 | 74 | 2095 | EXCRETION | URINARY EXCRETION OF QUINALDINE BY CHANNEL CATFISH KEYWORDS URINE CHANNEL-CATFISH QUI |
| 100 | 73 | 2226 | EXCRETION | INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH LEPOMI |
| 200 | 75 | 2693 | EXHAUST-SYSTEMS | EXHAUST SYSTEMS FOR UNDERFLOOR LIQUID MANURE PITS KEYWORDS ODOR AIR-POLLUTION DESIGN |
| 400 | 74 | 1920 | EXPERIMENTAL-FARMS | FARMLAND FARM STRESSES NO RUNOFF LATEST TEST RESULTS KEYWORDS AGRICULTURAL-RUNOFF LIVE |
| 400 | 75 | 2055 | EXPORT | THEY PLAN TO EXPORT LIQUID MANURE TO THE ARABS KEYWORDS LIQUID-WASTES EXPORT FERTILIZE |
| 200 | 73 | 2101 | EXPOSURE-CHAMBERS | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 100 | 69 | 2380 | EXTENDED-AERATION | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS KEYWORDS WAST |
| 400 | 73 | 1854 | EYE-IRRITATION | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES KEYWORDS AMMONIA LITTER BROILERS V |
| 700 | 67 | 1651 | E-COLI | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 400 | 72 | 2554 | E-COLI | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 100 | 71 | 2767 | E-COLI | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 300 | 72 | 1628 | FACILITIES | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 100 | 73 | 1673 | FACILITIES | TROUT METABOLISM CHARACTERISTICS AND THE RATIONAL DESIGN OF NITRIFICATION FACILITIES FO |
| 400 | 72 | 1834 | FACILITIES | FEEDLOT DESIGN AND CONSTRUCTION KEYWORDS FEEDLOTS CONSTRUCTION DESIGN FACILITIES CATT |
| 300 | 70 | 1839 | FACILITIES | ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL SYSTEMS FOR DAIRY CATTLE KEYWORDS LIQUI |
| 300 | 73 | 2096 | FACILITY-DESIGN | SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING KEYWORDS WASTE-DISPOSAL SLABS COSTS ODORS LA |
| 300 | 68 | 1625 | FACULTATIVE-BACTER | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 100 | 74 | 2258 | FACULTATIVE-BACTER | THE BACTERIAL POPULATION OF PIGGERY WASTE ANAEROBIC DIGESTERS KEYWORDS ANAEROBIC-DIGE |
| 100 | 73 | 1790 | FAECES-COLLECTOR | A FAECES COLLECTOR SUITABLE FOR MALE CALVES KEYWORDS CATTLE FAECES-COLLECTOR MALE-CAL |
| 300 | 74 | 1860 | FALLOUT | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 300 | 72 | 1775 | FAMILY-OPERATED-FA | ECONOMIC IMPLICATIONS OF WATER POLLUTION ABATEMENT IN FAMILY FARM LIVESTOCK PRODUCTION |
| 300 | 74 | 2428 | FANS | UNDERFLOOR VENTILATION FOR SLOTTED FLOOR SWINE BUILDINGS KEYWORDS VENTILATION DESIGN C |
| 600 | 71 | 1729 | FARMS | EPA S ROLE IN THE ANIMAL WASTE PROBLEM-PANEL DISCUSSION KEYWORDS FARMS COSTS FEDERAL-G |
| 200 | 74 | 2143 | FARMS | POLLUTION ABATEMENT ON FARMSTEADS KEYWORDS POLLUTION-ABATEMENT COSTS FARMS GOVERNMENT |
| 300 | 73 | 1915 | FARM-MANAGEMENT | METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURC |
| 600 | 72 | 2122 | FARM-MANAGEMENT | CONFINEMENT HOUSING SYSTEMS FOR SOWS KEYWORDS CONFINEMENT-PENS BREEDING WASTE-DISPOSA |
| 300 | 73 | 2243 | FARM-MANAGEMENT | CONFINEMENT LIVESTOCK FACILITIES WASTE MANAGEMENT CODE OF PRACTICE KEYWORDS CANADA AL |
| 200 | 73 | 2477 | FARM-MANAGEMENT | EFFECTS OF WASTE MANAGEMENT SYSTEMS ON THE ANIMALS ENVIRONMENT KEYWORDS CONFINEMENT-P |
| 200 | 75 | 2705 | FARM-MANAGEMENT | LIVESTOCK AGRICULTURE IN THE STATE OF HAWAII A REGIONAL APPROACH TO WASTE MANAGEMENT K |
| 400 | 74 | 1799 | FARM-POLLUTION | FARM POLLUTION-HOW REGULATIONS AFFECT YOU KEYWORDS PERMITS REGULATION LIVESTOCK FARM-W |
| 100 | 73 | 1637 | FARM-WASTES | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 200 | 74 | 1649 | FARM-WASTES | COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE KEYWORDS MUNICIPAL-WASTES FEEDLOTS FARM-W |
| 100 | 73 | 1664 | FARM-WASTES | A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED |
| 700 | 71 | 1665 | FARM-WASTES | MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM WASTE LAGOON KEYWORDS FAR |
| 600 | 73 | 1682 | FARM-WASTES | POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN KEYWORDS FAR |
| 600 | 74 | 1686 | FARM-WASTES | AEROBIC TREATMENT OF POULTRY WASTES KEYWORDS AEROBIC-TREATMENT FARM-WASTES POULTRY OD |
| 200 | 64 | 1696 | FARM-WASTES | ANAEROBIC LAGOONS THEORY AND PRACTICE KEYWORDS ANAEROBIC-LAGOONS DESIGN WASTE-TREATMEN |
| 600 | 73 | 1710 | FARM-WASTES | MONITORING ON FARM WASTE MANAGEMENT SYSTEMS KEYWORDS MONITORING FARM-WASTES MANAGEMENT |
| 600 | 71 | 1715 | FARM-WASTES | THE STATE AND REGIONAL SITUATION KEYWORDS FEEDLOTS CONFINEMENT-PENS FARM-WASTES LIVES |
| 600 | 71 | 1717 | FARM-WASTES | AEROBIC WASTE TREATMENT KEYWORDS AEROBIC-TREATMENT OXIDATION-LAGOONS AERATED-LAGOONS |
| 600 | 71 | 1724 | FARM-WASTES | WASTE APPLICATION TO SOILS KEYWORDS FARM-WASTES APPLICATION-METHODS SOILS FERTILIZERS |
| 300 | 71 | 1739 | FARM-WASTES | CATTLE FEEDLOT POLLUTION STUDY KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL CATTLE FEEDLOT |
| 100 | 73 | 1795 | FARM-WASTES | AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES KEYWORDS SAMPLING SOILS NI |
| 700 | 71 | 1762 | FARM-WASTES | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |

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|---|---|---|---|---|
| 600 | 73 | 1763 | FARM-WASTES | DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR KEYWORDS DRYING FA |
| 300 | 72 | 1775 | FARM-WASTES | ECONOMIC IMPLICATIONS OF WATER POLLUTION ABATEMENT IN FAMILY FARM LIVESTOCK PRODUCTION |
| 400 | 74 | 1797 | FARM-WASTES | WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF KEYWORDS FARM-WASTES WASTE-DISPOSAL |
| 400 | 74 | 1799 | FARM-WASTES | FARM POLLUTION-HOW REGULATIONS AFFECT YOU KEYWORDS PERMITS REGULATION LIVESTOCK FARM-W |
| 400 | 73 | 1858 | FARM-WASTES | FERMENTATION HEADS FOR HIGHER PRODUCTIVITY KEYWORDS FERMENTATION RECYCLING WASTE-TREAT |
| 400 | 73 | 1859 | FARM-WASTES | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 100 | 71 | 1872 | FARM-WASTES | AGRICULTURE THE SEEDS OF A PROBLEM KEYWORDS AGRICULTURE FARM-WASTES FORESTRY WASTE-DI |
| 300 | 71 | 1882 | FARM-WASTES | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 200 | 73 | 1895 | FARM-WASTES | AGRICULTURAL WASTES AND GROUND WATER QUALITY KEYWORDS WATER-POLLUTION-SOURCES FARM-WAS |
| 300 | 73 | 1915 | FARM-WASTES | METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURC |
| 200 | 71 | 1925 | FARM-WASTES | SOIL CONSERVATION SERVICE TEXAS TECH UNIVERSITY WORKSHOP COMMITTEE ON FEEDLOT WASTE KE |
| 200 | 71 | 1962 | FARM-WASTES | PROCEEDINGS OF CONFERENCES ON FARM ANIMAL WASTES NITRATES AND PHOSPHATES IN RURAL WISCO |
| 200 | 69 | 1981 | FARM-WASTES | DEHYDRATION AN ECONOMICAL SOLUTION TO POULTRY MANURE PROBLEMS KEYWORDS DEHYDRATION EC |
| 400 | 71 | 1985 | FARM-WASTES | IRRIGATION RESIDUES KEYWORDS IRRIGATION-EFFECTS POLLUTANTS WATER-QUALITY-CONTROL WAST |
| 400 | 72 | 2036 | FARM-WASTES | PROFIT TOO IN MANURE FROM PLASTIC PENS KEYWORDS FARM-WASTES POULTRY ECONOMICS WASTE-T |
| 100 | 71 | 2092 | FARM-WASTES | FARM EFFLUENT-ELECTRICAL DISPOSAL METHODS KEYWORDS EFFLUENTS FARM-WASTES SUSPENDED-SOL |
| 400 | 74 | 2094 | FARM-WASTES | NEW ODOR CONTROL PRODUCT NOW AVAILABLE KEYWORDS ODOR CONTROL BACTERIA FEEDLOTS FARM-W |
| 400 | 75 | 2107 | FARM-WASTES | FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED KEYWORDS DESIGN CONSTRUC |
| 100 | 73 | 2111 | FARM-WASTES | AGRICULTURAL RESEARCH CONCENTRATES ON FARM WASTE KEYWORDS FARM-WASTES EFFLUENT SLURRI |
| 300 | 71 | 2133 | FARM-WASTES | ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT-TECHNOLOGY AND ECONOMICS PHASE I KEYW |
| 400 | 74 | 2172 | FARM-WASTES | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
| 600 | 69 | 2179 | FARM-WASTES | THE EFFECT OF FARM WASTES ON THE POLLUTION OF NATURAL WATER KEYWORDS FARM-WASTES WATE |
| 100 | 74 | 2184 | FARM-WASTES | METHANE PRODUCTION FROM WASTE KEYWORDS METHANE METHANE-BACTERIA SEWAGE WASTE-TREATMEN |
| 200 | 74 | 2185 | FARM-WASTES | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 100 | 72 | 2186 | FARM-WASTES | HANDLING MILKING PARLOR WASTE KEYWORDS DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM |
| 100 | 72 | 2187 | FARM-WASTES | NITRATES IN SOIL AND GROUND WATER BENEATH IRRIGATED AND FERTILIZED CROPS KEYWORDS NIT |
| 700 | 65 | 2188 | FARM-WASTES | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 100 | 74 | 2189 | FARM-WASTES | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 100 | 72 | 2190 | FARM-WASTES | AGRICULTURAL RUNOFF CHARACTERISTICS AND CONTROL KEYWORDS AGRICULTURAL-RUNOFF CONTROL E |
| 700 | 63 | 2233 | FARM-WASTES | CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE KEYWORDS FARM-WASTES HOGS ANAE |
| 700 | 67 | 2234 | FARM-WASTES | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 700 | 72 | 2319 | FARM-WASTES | THE MICROBIAL ECOLOGY OF CULTIVATED SOIL RECEIVING COW MANURE WASTE KEYWORDS FARM-WAS |
| 400 | 75 | 2330 | FARM-WASTES | BRITISH GROUP ENCOURAGING WASTE RECYCLING KEYWORDS RECYCLING FARM-WASTES GREAT-BRITAIN |
| 700 | 74 | 2362 | FARM-WASTES | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 200 | 69 | 2383 | FARM-WASTES | ECONOMIC ASPECTS OF FEEDLOT WASTE POLLUTION KEYWORDS ECONOMICS FEEDLOTS FARM-WASTES ST |
| 300 | 74 | 2388 | FARM-WASTES | SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE KEYWORD |
| 100 | 48 | 2400 | FARM-WASTES | RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE KEYWORDS FARM-WAST |
| 700 | 74 | 2405 | FARM-WASTES | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 300 | 73 | 2407 | FARM-WASTES | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS EFFLUE |
| 100 | 74 | 2408 | FARM-WASTES | REVIEW PAPER-ANIMAL WASTES MANAGEMENT AND CHARACTERIZATION KEYWORDS FARM-WASTES PHYSI |
| 300 | 48 | 2414 | FARM-WASTES | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION KEYWORDS POULTRY FARM- |
| 100 | 75 | 2422 | FARM-WASTES | WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS |
| 400 | 75 | 2425 | FARM-WASTES | UTILIZING WASTES IN ANIMAL FEEDS-A EUROPEAN OVERVIEW KEYWORDS RECYCLING ORGANIC-WASTE |
| 200 | 73 | 2442 | FARM-WASTES | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES LI |
| 300 | 74 | 2452 | FARM-WASTES | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 200 | 64 | 2566 | FARM-WASTES | NEWER ASPECTS IN TREATMENT OF PACKING HOUSE AND FEEDLOT WASTES KEYWORDS WASTE-TREATME |
| 200 | 75 | 2644 | FARM-WASTES | NUTRIENT AVAILABILITY FROM OXIDATION DITCHES KEYWORDS NUTRIENTS AEROBIC-TREATMENT FARM |
| 200 | 75 | 2681 | FARM-WASTES | MODIFICATION AND ENZYMATIC HYDROLYSIS OF FEEDLOT WASTE KEYWORDS HYDROLYSIS FEEDLOTS MU |
| 600 | | 2777 | FARM-WASTES | GROUND WATER CONTAMINATION BY DISSOLVED NITRATE KEYWORDS NITRATES FERTILIZERS GEOCHEMI |
| 100 | 73 | 2779 | FARM-WASTES | HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE KEYWORDS COMPOSTING MUNIC |
| 100 | 71 | 2787 | FARM-WASTES | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 100 | 73 | 2798 | FARM-WASTES | EFFECT OF NITROGEN AND FARM YARD MANURE ON FINGER MILLET ELEUSINE CORACANA L GAERTN KE |
| 400 | 73 | 1633 | FAST-FLUSH-SYSTEM | FAST FLUSH SYSTEM KEYWORDS FAST-FLUSH-SYSTEM CATTLE WASTE-TREATMENT WASTE-DISPOSAL FE |
| 100 | 73 | 2332 | FATIGUE | ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS KEYWORD |
| 100 | 73 | 1637 | FATS | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 300 | 68 | 1948 | FATTENING-HEIFERS | THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF MAN |
| 100 | 75 | 2543 | FATTY-ACIDS | METHODS FOR MEASURING SHORT CHAIN FATTY ACIDS AND AMMONIA FROM ANIMAL WASTES KEYWORDS |
| 300 | 71 | 1903 | FEASIBILITY | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 100 | 63 | 2549 | FEASIBILITY | SLUDGE DIGESTION OF FARM ANIMAL WASTES KEYWORDS SLUDGE-DIGESTION ECONOMICS FEASIBILIT |
| 600 | 74 | 2050 | FEASIBILITY-STUDIE | METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR KEYWORDS METHANE FEASIBILITY-S |
| 400 | 73 | 2103 | FEASIBILITY-STUDIE | SLAB VS SLAT-AN EXPERT S OPINION KEYWORDS CONFINEMENT-PENS WASTE-DISPOSAL DESIGN ARIZ |
| 200 | 72 | 2168 | FEASIBILITY-STUDIE | THERMOCHEMICAL EVALUATION OF ANIMAL WASTE CONVERSION PROCESSES KEYWORDS RECYCLING GAS |
| 200 | 75 | 2591 | FEASIBILITY-STUDIE | AN ECONOMIC ANALYSIS OF METHANE GENERATION FEASIBILITY ON COMMERCIAL EGG FARMS KEYWORD |
| 200 | 75 | 2722 | FEASIBILITY-STUDIE | DRYING OF POULTRY MANURE AN ECONOMIC AND TECHNICAL FEASIBILITY STUDY KEYWORDS ECONOMI |
| 200 | 75 | 2744 | FEASIBILITY-STUDIE | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 200 | 64 | 1694 | FEATHERS | ODORS AND THEIR CONTROL KEYWORDS ODOR CONTROL EQUIPMENT POULTRY EXCRETA FEATHERS ANAE |
| 200 | 74 | 2005 | FEATHERS | INTEGRATED POULTRY MANURE HANDLING USING FLUSH TRAYS UNDER CAGES AND RENOVATED WASTEWA |
| 300 | 73 | 1620 | FEATHER-FOLLICLES | PROTOTYPE OF A BROILER CAGE SYSTEM KEYWORDS BROILERS PERFORMANCE CAGE-SYSTEM CROSS-AU |
| 400 | 74 | 2232 | FECAL-COLIFORMS | EPA AND THE FISH FARMER KEYWORDS FISH-FARMING REGULATIONS EFFLUENT PONDS SUSPENDED-S |
| 200 | 75 | 2586 | FECAL-COLIFORMS | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS BA |
| 200 | 75 | 2587 | FECAL-COLIFORMS | SURVIVAL OF SALMONELLAE TOTAL COLIFORMS AND FECAL COLIFORMS IN SWINE WASTE LAGOON EFFLU |
| 700 | 72 | 2319 | FECAL-COLIFORM | THE MICROBIAL ECOLOGY OF CULTIVATED SOIL RECEIVING COW MANURE WASTE KEYWORDS FARM-WAS |
| 100 | 73 | 2325 | FECAL-PATS | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 200 | 75 | 2586 | FECAL-STREPTOCOCCI | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS BA |
| 100 | 61 | 1669 | FECES | TOXICITY TO FLY LARVAE OF THE FECES OF INSECTICIDE FED CATTLE KEYWORDS TOXICITY CATTL |
| 100 | 61 | 1670 | FECES | TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE FED CATTLE KEYWORD |
| 300 | 71 | 1672 | FECES | EFFECT OF APPLYING SWINE FECES ON SOIL AND PLANT MINERAL LEVELS KEYWORDS SWINE FECES |
| 100 | 60 | 1677 | FECES | FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES KEYWORDS FEED-ADDIT |
| 200 | 74 | 2021 | FECES | NUTRITIVE VALUE OF AMINO ACID PRODUCED IN AN OXIDATION DITCH FROM WASTE KEYWORDS PROT |
| 400 | 75 | 2251 | FECES | FERTILIZER FEED VALUE OF SWINE WASTES DETAILED KEYWORDS RECYCLING FERTILIZERS FEEDS SW |
| 400 | 72 | 2305 | FECES | PROCESSED POULTRY MANURE AS A FEEDSTUFF KEYWORDS POULTRY PERFORMANCE PHOSPHORUS AMIN |
| 200 | 70 | 2347 | FECES | CONCENTRATIONS AND CYCLES OF BACTERIAL INDICATORS IN FARM SURFACE RUNOFF KEYWORDS WAT |
| 100 | 71 | 2551 | FECES | COMPARATIVE EVALUATION OF SOME TECHNIQUES USED IN DETERMINATIONS OF NITROGEN AND ENERGY |
| 600 | 71 | 1729 | FEDERAL-GOVERNMENT | EPA S ROLE IN THE ANIMAL WASTE PROBLEM-PANEL DISCUSSION KEYWORDS FARMS COSTS FEDERAL-G |
| 600 | 71 | 1729 | FEDERAL-PROGRAMS | EPA S ROLE IN THE ANIMAL WASTE PROBLEM-PANEL DISCUSSION KEYWORDS FARMS COSTS FEDERAL-G |
| 200 | 75 | 2596 | FEDERAL-WATER-POLL | EFFECTS OF ENVIRONMENTAL LEGISLATION ON CATTLE FEEDLOT LOCATION KEYWORDS MODEL-STUDIE |
| 200 | 75 | 2597 | FEDERAL-WATER-POLL | ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTION CONTROL RULES ON THE UNITED STATES |
| 200 | 75 | 2600 | FEDERAL-WATER-POLL | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |
| 200 | 75 | 2603 | FEDERAL-WATER-POLL | THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION |
| 400 | 74 | 1883 | FEEDING | CUSTOM CATTLE FEEDING MOVES TO THE SOUTHEAST KEYWORDS CATTLE SOUTHEAST-U-S WASTE-DISPO |
| 600 | 72 | 2122 | FEEDING | CONFINEMENT HOUSING SYSTEMS FOR SOWS KEYWORDS CONFINEMENT-PENS BREEDING WASTE-DISPOSA |
| 300 | 72 | 2367 | FEEDING | A COMPARISON OF FIVE HOUSING SYSTEMS FOR FEEDLOT CATTLE KEYWORDS FEEDLOTS CONFINEMENT- |
| 400 | 75 | 2344 | FEEDING-RATES | SEPARATING SOLID WASTE FROM LIQUID KEYWORDS SOLID-WASTES LIQUID-WASTES CATTLE RECYCL |
| 200 | 74 | 2014 | FEEDING-SYSTEMS | INFLUENCE ON FEEDING SYSTEM DIGESTIBILITY OF RATION AND PROPORTION OF CONCENTRATE CONSU |
| 600 | 69 | 2175 | FEEDING-SYSTEMS | THE DESIGN AND OPERATION OF AN OPEN FRONT SLOTTED FLOOR BEEF CONFINEMENT BUILDING KEYW |
| 300 | 71 | 1903 | FEEDING-VALUE | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 300 | 73 | 1617 | FEEDLOTS | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 100 | 72 | 1621 | FEEDLOTS | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 300 | 72 | 1628 | FEEDLOTS | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 300 | 74 | 1629 | FEEDLOTS | CONTROL OF DUST FROM CATTLE FEEDLOTS KEYWORDS CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN |

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400 73 1633   FEEDLOTS        FAST FLUSH SYSTEM  KEYWORDS  FAST-FLUSH-SYSTEM CATTLE WASTE-TREATMENT WASTE-DISPOSAL FE
400 73 1634   FEEDLOTS        HE SOLVED HIS MANURE HANDLING PROBLEM  KEYWORDS  WASTE-HANDLING DAIRY-INDUSTRY AGRICULT
400 73 1638   FEEDLOTS        EPA PREPARING TO RAILROAD THROUGH NEW POLLUTION RULES COVERING CATTLE FEEDLOTS  KEYWORD
200 73 1648   FEEDLOTS        ODOR INTENSITIES AT CATTLE FEEDLOTS  KEYWORDS  ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC
200 74 1649   FEEDLOTS        COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE  KEYWORDS MUNICIPAL-WASTES FEEDLOTS FARM-W
700 73 1652   FEEDLOTS        DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS  WASTE-TREATMENT AGR
700 69 1656   FEEDLOTS        MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF  KEYWORDS  MATHEMATI
400 73 1662   FEEDLOTS        THESE STOCKYARDS SOLUTIONS COULD WORK FOR YOU  KEYWORDS LIVESTOCK FEEDLOTS MANAGEMENT L
100 73 1664   FEEDLOTS        A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS  KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED
600 74 1671   FEEDLOTS        PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS  KEYWORDS  FEEDLOTS AGRICULT
400 74 1676   FEEDLOTS        ORGANIC FERTILIZER OFFSHOOT OF POLLUTION FREE FEEDLOT  KEYWORDS  FERTILIZERS POLLUTION
300 74 1678   FEEDLOTS        LOCATING A NEW FEEDLOT  KEYWORDS  FEEDLOTS SITE-SELECTION WATER-POLLUTION LIVESTOCK REG
700 70 1680   FEEDLOTS        EFFECT OF FEEDLOT LAGOON WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED KAN
600 73 1682   FEEDLOTS        POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN  KEYWORDS  FAR
600 74 1684   FEEDLOTS        OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS  KEYWORDS  CATTLE FEEDL
700 71 1688   FEEDLOTS        THE AEROBIC DECOMPOSITION OF SOLID BEEF CATTLE FEEDLOT WASTE  KEYWORDS  AEROBIC-TREATME
700 69 1690   FEEDLOTS        ZETA POTENTIAL OF COLLOIDAL SUSPENSIONS FROM A BEEF CATTLE FEEDLOT SURFACE  KEYWORDS  ZE
200 64 1695   FEEDLOTS        IDENTIFICATION AND CONTROL OF ODORS FROM ANIMAL WASTES KEYWORDS  ODOR-CONTROL ANAEROBIC
700 72 1706   FEEDLOTS        WATER QUALITY OF STORM RUNOFF FROM A TEXAS BEEF FEEDLOT KEYWORDS  WATER-QUALITY STORM-R
600 73 1710   FEEDLOTS        MONITORING ON FARM WASTE MANAGEMENT SYSTEMS  KEYWORDS MONITORING FARM-WASTES MANAGEMENT
600 71 1713   FEEDLOTS        ANIMAL WASTE MANAGEMENT CONFERENCE KEYWORDS  WASTE-MANAGEMENT LIVESTOCK CONFINEMENT-PEN
600 71 1714   FEEDLOTS        ANIMAL WASTE MANAGEMENT-COMMENTS ON THE NATIONAL SITUATION  KEYWORDS  WASTE-MANAGEMENT
600 71 1715   FEEDLOTS        THE STATE AND REGIONAL SITUATION  KEYWORDS  FEEDLOTS CONFINEMENT-PENS FARM-WASTES LIVES
600 71 1718   FEEDLOTS        SYSTEM COMPONENTS TO SEPARATE SOLIDS AND LIQUIDS  KEYWORDS  SOLID-WASTES LIQUID-WASTES
600 71 1720   FEEDLOTS        NATURE AND BEHAVIOR OF MANURE  KEYWORDS  WATER-POLLUTION FEEDLOTS AGRICULTURAL-RUNOFF M
600 71 1721   FEEDLOTS        DESIGN CONSIDERATIONS IN FEEDLOT RUNOFF CONTROL  KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF
300 73 1733   FEEDLOTS        THE ECONOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA KEYWORDS  FEEDLOTS CATTLE ZONIN
700 69 1734   FEEDLOTS        DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE  KEYWORDS FEEDS RECYCLING WASTELAGE DIGEST
300 71 1739   FEEDLOTS        CATTLE FEEDLOT POLLUTION STUDY  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL CATTLE FEEDLOT
600 74 1744   FEEDLOTS        FIELD PERFORMANCE OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS  KEYWORDS  CATTLE WAS
300 73 1745   FEEDLOTS        GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS KEYWORDS  FEEDLOTS MANURE CATTLE
600 72 1753   FEEDLOTS        BUFFALO LAKE RECREATIONAL WATER QUALITY A STUDY IN BACTERIOLOGICAL DATA INTERPRETATION
600 73 1754   FEEDLOTS        BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING KEYWORDS  FEEDLOTS AGRICULTUR
600 74 1756   FEEDLOTS        ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS  AGRICULTURAL-RUNOFF AN
300 73 1759   FEEDLOTS        POLLUTION FROM ANIMAL FEEDLOTS  KEYWORDS  FEEDLOTS WATER-POLLUTION-SOURCES AGRICULTURAL
700 71 1761   FEEDLOTS        HYDROLOGIC AND WATER QUALITY CHARACTERISTICS OF BEEF FEEDLOT RUNOFF  KEYWORDS  HYDROLOG
400 73 1778   FEEDLOTS        MODELS FOR HANDLING SOLID MANURE  KEYWORDS  SOLID-WASTES MANAGEMENT HANDLING FEEDLOTS M
700 70 1779   FEEDLOTS        THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS  KEYWORDS  NITROGEN FEEDLOTS SOILS CAT
300 74 1783   FEEDLOTS        QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION  THROUGH SOIL UNDER NATIVE P
300 73 1785   FEEDLOTS        NITROGENOUS COMPOUNDS IN THE ENVIRONMENT  KEYWORDS  FEEDLOTS WASTE-WATER-TREATMENT WATE
100 72 1788   FEEDLOTS        MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES  KEYWORDS  FEEDLOTS CATTLE A
300    1792   FEEDLOTS        SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF
400 74 1797   FEEDLOTS        WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF  KEYWORDS  FARM-WASTES WASTE-DISPOSAL
600 73 1803   FEEDLOTS        FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE C
400 72 1804   FEEDLOTS        FEEDLOT DESIGN AND CONSTRUCTION  KEYWORDS  FEEDLOTS CONSTRUCTION DESIGN FACILITIES CATT
200 70 1805   FEEDLOTS        FEEDLOT WASTE MANAGEMENT SYSTEMS  KEYWORDS  FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT
100 73 1806   FEEDLOTS        FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL  KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN
400 72 1807   FEEDLOTS        CONFINEMENT PAYS IF WEATHER IS BAD  KEYWORDS  CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL
400 74 1808   FEEDLOTS        MONFORT FUELS FEEDLOT AND PLANT WITH MANURE  KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA
400 73 1811   FEEDLOTS        AVERT RUNOFF POLLUTION  KEYWORDS  AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P
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200 64 2567  FEEDLOTS            STREAM POLLUTION FROM FEEDLOT RUNOFF  KEYWORDS  WATER-POLLUTION AGRICULTURAL-RUNOFF FEE
100 71 2570  FEEDLOTS            BIOCONCENTRATION AND BICTRANSFER OF AFLATOXIN  KEYWORDS MICROORGANISMS TOXICITY FEEDLOT
300    2571  FEEDLCTS            LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS  LEGAL-ASPECTS FEEDLOTS NE
400 72 2573  FEEDLCTS            A LIVESTOCKMANS GUIDE TO POLLUTION LAWS  KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT
400 75 2575  FEEDLCTS            ME USES VALUABLE RUNOFF  KEYWORDS  AGRICULTURAL-RUNCFF DRAINAGE FEEDLOTS FERTILIZERS CO
100 72 2580  FEEDLCTS            THE TREATMENT OF LIVESTOCK WASTES  KEYWORDS  LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE
200 75 2592  FEEDLOTS            ECONOMICS OF SUBSTITUTICN AND THE DEMAND FOR BEEF FEEDLOT WASTES-ONE ALTERNATIVE FOR SO
200 75 2594  FEEDLCTS            ECCNOMICS OF ALTERNATIVE BEEF WASTE MANAGEMENT SYSTEMS KEYWORDS  ECONOMICS CATTLE FEEDL
200 75 2595  FEECLOTS            ECONOMIC IMPACTS OF ALTERNATIVE WATER PCLLUTION CONTROL RULES ON BEEF FEEDLOTS OF LESS
200 75 2597  FEEDLCTS            ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTICN CONTROL RULES ON THE UNITED STATES
200 75 2600  FEEDLCTS            FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY CPERATIONS KEYWORDS  LEGISLATION FEED
200 75 2601  FEEDLCTS            LEGAL ASPECTS OF ODCR POLLUTION CONTROL  KEYWORDS  AIR-POLLUTION LEGISLATION FEEDLOTS L
200 75 2602  FEEDLCTS            PARTNERSHIP IN POLLUTION CONTROL  KEYWORDS  WATER-POLLUTION LEGISLATION FEEDLOTS ILLINO
200 75 2603  FEEDLCTS            THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES  KEYWORDS  REGULATION
200 75 2608  FEEDLCTS            CONTROL COLLECTION AND DISPOSAL OF FEEDLOT RUNOFF  KEYWORDS  REGULATION ENGINEERING DES
200 75 2609  FEEDLCTS            MANAGEMENT OF RUNOFF WATER IN RELATICN TO FEEDLCT OPERATIONS KEYWORDS  AGRICULTURAL-RUN
200 75 2610  FEECLOTS            AN ILLINOIS FEEDLOT RUNOFF CONTROL PROJECT  KEYWORDS  ILLINOIS FEEDLOTS DESIGN SPRINKLE
200 75 2611  FEEDLCTS            FEEDLOT WASTE RECYCLING WITH A FLUSH CLEANING SYSTEM KEYWORDS  FEEDLOTS WASTE-STORAGE W
200 75 2647  FEEDLCTS            NUTRITIONAL PROPERTIES CF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS  KEYWORDS  NUTR
200 75 2648  FEEDLOTS            NUTRITICNAL VALUE OF CATTLE FEEDLOT WASTE FOR GROWING- FINISHING BEEF CATTLE  KEYWORDS
200 75 2657  FEECLCTS            PRODUCT APPLICATICNS OF TREATED LIVESTOCK WASTE  KEYWORDS RECYCLING PIGMENTS FEEDLOTS C
200 75 2660  FEEDLCTS            RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE CN GRAIN SORGHUM YIELDS  KEYWORDS  FERTILIZE
200 75 2663  FEEDLCTS            DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND  KEYWCRDS FEEDLOTS CATTLE KANSAS CROP-RESPONS
200 75 2671  FEEDLOTS            SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS  KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN
200 75 2681  FEEDLOTS            MODIFICATION AND ENZYMATIC HYDROLYSIS OF FEEDLOT WASTE KEYWORDS  HYDROLYSIS FEEDLOTS NU
200 75 2685  FEEDLOTS            EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TC VARIATIONS IN CONCENTRATIONS OF SOD
200 75 2687  FEEDLOTS            DECOMPOSITION RATES OF BEEF CATTLE WASTES  KEYWCRDS ORGANIC-WASTES CATTLE RECYCLING CHE
200 75 2688  FEEDLOTS            CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE  KEYWORD
200 75 2691  FEEDLOTS            EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS  KEYWORDS  FEED
200 75 2694  FEEDLCTS            MALCOOR REDUCTION IN BEEF CATTLE FEEDLOTS  KEYWCRDS FEEDLOTS CATTLE ODOR-CONTROL CHEMIC
200 75 2706  FEEDLOTS            ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS  KEYWORDS  AGRICUL
200 75 2708  FEEDLOTS            MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN  COLD CLIMATES  KEYWORDS  IR
200 75 2709  FEEDLOTS            RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA  KEYWORDS  AGRIC
200 75 2710  FEEDLCTS            DESIGN RUNOFF VOLUME FROM FEEDLOTS IN THE SOUTHWESTERN GREAT PLAINS  KEYWORDS  DESIGN A
700 74 2765  FEEDLCTS            ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE  ON THE FEEDLOT SOIL PROFILE
700 73 2772  FEEDLOTS            ECONOMICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS COMPLYING WITH POLLUTION-CONTROL-REGU
600 71 2778  FEEDLOTS            A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT
700 70 2781  FEECLCTS            AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS  KEYWOR
300 69 2797  FEEDLOTS            MANAGEMENT AND CONTROL OF BEEF FEEDLCT WASTE  KEYWORDS FEEDLOTS CATTLE NEBRASKA REGULAT
100 72 2799  FEEDLOTS            RETORTING FEEDLOT WASTES  KEYWORDS  FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO
400 70 2803  FEEDLOTS            FEEDLOT POLLUTION-A SOLVABLE PROBLEM  KEYWORDS  AGRICULTURAL-RUNOFF WATER-POLLUTION SOU
400 72 2805  FEEDLOTS            FEEDLOT WASTE USABLE  KEYWORDS  FEEDLOTS RECYCLING FEEDS PERFORMANCE FRACTIONATION BUIL
100 72 2811  FEEDLOTS            THE USE OF ANIMAL WASTES ON FERTILIZER  KEYWORDS  FERTILIZERS IRRIGATION ANIMAL-WASTES
300 74 2257  FEEDLOT-EFFLUENT-S CURRENT LIVESTOCK POLLUTION REGULATIONS  KEYWORDS  WATER-POLLUTION PERMITS LIVESTOCK PO
100 73 1664  FEEDLOT-RESEARCH   A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS  KEYWCRDS FEEDLOTS AGRICULTURAL-RUNOFF BED
700 73 1890  FEEDLOT-RUNOFF     LABORATORY STUDIES ON FEEDLOT RUNOFF  KEYWORDS  ANIMAL-WASTES AGRICULTURAL-RUNOFF FEEDL
700 74 2564  FEEDLCT-SURFACE    PHYSICAL CHARACTERISTICS OF THE SURFACE AND INTERFACE LAYERS OF A LEVEL BEEF CATTLE FEE
200 71 1926  FEEDLCT-SURFACING  FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS  KEYWORDS  LIQUID-W
300 73 1622  FEEDLOT-WASTES     THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS  KEYWORDS  RECYCLING QUALITATIVE-ORG
700 73 1890  FEECLOT-WASTES     LABORATORY STUDIES ON FEEDLCT RUNOFF  KEYWORDS  ANIMAL-WASTES AGRICULTURAL-RUNOFF FEEDL
100 68 2788  FEEDLOT-WASTES     THE FLOW OF SOLID WASTES IN PIPELINES  KEYWORDS SOLID-WASTES HYDRAULIC-TRANSPORTATION P
400 73 1618  FEEDS              THEY BEAT THE HIGH COST OF PROTEIN WITH PLS  KEYWORDS  COSTS PROTEINS FEEDS POULTRY LIT
100 72 1621  FEEDS              SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW  KEYWORDS  FEEDLOTS ODOR-
400 73 1632  FEEDS              FEEDING STEERS DPM  KEYWORDS  FEEDS POULTRY CATTLE PROTEINS PERFORMANCE DEHYDRATED-POUL
100 73 1637  FEEDS              HIGH FAT RATIONS FOR RUMINANTS  II  EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T
200 72 1645  FEEDS              ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING  KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC
700 71 1665  FEEDS              MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM  WASTE LAGOON  KEYWORDS  FAR
600 71 1725  FEEDS              ANIMAL WASTE REUSE  KEYWORDS  RECYCLING FEEDS POULTRY CATTLE PROTEINS INSECTICIDES COST
700 69 1734  FEEDS              DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE  KEYWORDS FEEDS RECYCLING WASTELAGE DIGEST
100 73 1747  FEEDS              FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS KEYWORDS  DIETS POULTRY PROTEINS
200 69 1760  FEEDS              HYDRAULIC HANDLING OF PCULTRY MANURE INTEGRATED INTC AN ALGAL RECOVERY SYSTEM  KEYWORDS
700 71 1766  FEEDS              WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
400 74 1771  FEEDS              DPM S POULTRY FEED VALUE IS LIMITED  KEYWORDS  POULTRY FEEDS DRIED-POULTRY-WASTES REFEE
400 74 1772  FEEDS              DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS  POULTRY FEEDS DIET
200 73 1789  FEEDS              SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES  KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM
400 74 1797  FEEDS              WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF  KEYWORDS  FARM-WASTES WASTE-DISPOSAL
600 73 1803  FEEDS              FEEDLOT ANIMAL WASTE COMPARED WITH CCTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE C
400 73 1812  FEEDS              FEEDING VARIATIONS CAN AFFECT WASTE  KEYWORDS  FEEDS FEED-LOTS CONFINEMENT-PENS TEXAS C
400 72 1819  FEEDS              GE ENTERS MANURE RECYCLING RACE  KEYWORDS  MANURE FEEDLOTS  RECYCLING FEEDS PROTEINS WA
100 70 1823  FEEDS              GARDONA AS A FEED ADDITIVE FOR CONTRCL OF FLY LARVAE IN COW MANURE  KEYWORDS  FEEDS ADD
100 73 1833  FEEDS              AGRICULTURAL WASTES  KEYWORDS  LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC
400 72 1836  FEEDS              FEEDING POULTRY MANURE TO ANIMALS  KEYWORDS  FEEDS EXCRETA DEHYDRATED-POULTRY-WASTE SHE
300 73 1856  FEEDS              RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES  KEYWORDS  RUMINAN
400 73 1858  FEEDS              FERMENTATION HEADS FOR HIGHER PRODUCTIVITY  KEYWORDS FERMENTATION RECYCLING WASTE-TREAT
300 71 1903  FEEDS              FEEDING VALUE OF ANIMAL WASTES  KEYWORDS  FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA
400 69 1924  FEEDS              BIOLOGICAL DIGESTION OF MANURE BY DIPTERA  KEYWORDS  MANURE DIPTERA BIOLOGICAL-DIGESTIO
200 71 1926  FEEDS              FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS  KEYWORDS  LIQUID-W
400 71 1935  FEEDS              BARN WASTES FOR FEED  KEYWORDS  FEEDS RUMINANTS BARN-WASTES REFEEDING DIGESTIBILITY CHE
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# KEYWORD INDEX

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|---|---|---|---|---|
| 400 | 72 | 1938 | FEEDS | SAGEBRUSH FOR ODOR CONTROL-IN THE FEED OR THE MANURE KEYWORDS SAGEBRUSH FEEDS PERFORMA |
| 400 | 72 | 1939 | FEEDS | WASTE CONVERSION UNIT DEVELOPED KEYWORDS FEEDS METHANE FERMENTATION ANAEROBIC-CONDITI |
| 400 | 72 | 1940 | FEEDS | WARM WATER STUDY KEYWORDS REGULATION FEEDS ALGAE FEEDLOTS GENERATING-PLANT WARM-WATER |
| 400 | 72 | 1945 | FEEDS | THIS PLANT WILL CONVERT WASTE INTO PROTEIN KEYWORDS FEEDS PROTEINS THERMOPHILIC-BACTE |
| 400 | 73 | 1946 | FEEDS | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 300 | 68 | 1948 | FEEDS | THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF MAN |
| 100 | 74 | 1950 | FEEDS | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORD |
| 400 | 74 | 1955 | FEEDS | FEEDING PELLETED DRIED POULTRY LITTER TO HOLSTEIN STEERS KEYWORDS FEEDS PERFORMANCE CA |
| 300 | 74 | 1959 | FEEDS | ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS RECYCLING ANIMAL- |
| 200 | 74 | 1989 | FEEDS | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS PER |
| 200 | 74 | 2006 | FEEDS | CHARACTERIZATION OF WHITE LEGHORN MANURE KEYWORDS FEEDS MORTALITY MOISTURE-CONTENT WH |
| 200 | 74 | 2014 | FEEDS | INFLUENCE ON FEEDING SYSTEM DIGESTIBILITY OF RATION AND PROPORTION OF CONCENTRATE CONSU |
| 200 | 74 | 2021 | FEEDS | NUTRITIVE VALUE OF AMINO ACID PRODUCED IN AN OXIDATION DITCH FROM WASTE KEYWORDS PROT |
| 200 | 74 | 2022 | FEEDS | BEEF OXIDATION DITCH SETTLED SOLIDS FED TO STEERS KEYWORDS FEEDS CATTLE SOLID-WASTES P |
| 400 | 75 | 2040 | FEEDS | PROCESSED EXCRETA POTENTIALLY NUTRITIONAL KEYWORDS CATTLE FEEDS PROTEINS RECYCLING PE |
| 100 | 74 | 2047 | FEEDS | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 400 | 75 | 2049 | FEEDS | MANURE ROUGHAGE SILAGE FOR RUMINANTS KEYWORDS SILAGE RUMINANTS NUTRIENTS FEEDS NITROG |
| 300 | 73 | 2053 | FEEDS | SWINE WASTE AS NUTRIENT SOURCE FOR FINISHING PIGS KEYWORDS FEEDS NUTRIENTS PERFORMANC |
| 400 | 75 | 2056 | FEEDS | MILK PLUS MANURE-HIGHER DAIRY PROFITS KEYWORDS SEPARATION-TECHNIQUES DAIRY-INDUSTRY L |
| 400 | 73 | 2058 | FEEDS | POULTRY WASTES STUDIED FOR USE IN LIVESTOCK FEED KEYWORDS FEEDS LIVESTOCK PERFORMANCE |
| 100 | 72 | 2059 | FEEDS | RECYCLING OF ORGANIC WASTES WITH PROCESSING SYSTEM THAT PRECISELY CONTROLS HEAT AND FLO |
| 400 | 75 | 2071 | FEEDS | DUNG HO-FDA SETS REGS ON RECYCLED FEED KEYWORDS REGULATION RECYCLING ANIMAL-WASTES FE |
| 600 | 72 | 2074 | FEEDS | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE |
| 100 | 72 | 2112 | FEEDS | SHORT CUTS FROM MUCK TO MEALS KEYWORDS FEEDS RECLAMATION EFFLUENT FISH ALGAE MOLLUSK |
| 400 | 75 | 2116 | FEEDS | FEED PRICES ENVIRONMENTAL LAWS HELP SALES OUTLOOK FOR DRYING EQUIPMENT DPW KEYWORDS E |
| 400 | 73 | 2123 | FEEDS | DPW FOR RUMINANTS GROWS IN ENGLAND KEYWORDS PROTEINS COSTS FEEDS DRIED-POULTRY-MANURE |
| 400 | 75 | 2125 | FEEDS | CATTLE POULTRY PRODUCERS PUSH FOR RECYCLING RULES KEYWORDS CATTLE POULTRY ANIMAL-WAST |
| 400 | 73 | 2129 | FEEDS | DPW SAVES 26 75 PER TON OF LAYER FEED KEYWORDS COSTS ECONOMICS FEEDS POULTRY DRIED-PO |
| 400 | 74 | 2172 | FEEDS | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
| 300 | 74 | 2173 | FEEDS | PAUNCH CONTENT BLOODMEAL MIXTURE AS PROTEIN SUPPLEMENT IN FEEDLOT RATIONS KEYWORDS FE |
| 300 | 74 | 2177 | FEEDS | RECYCLING POULTRY WASTE AS FEED WILL IT PAY KEYWORDS RECYCLING FEEDS ECONOMICS INCINER |
| 300 | 74 | 2217 | FEEDS | COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING |
| 400 | 72 | 2239 | FEEDS | ARIZONA FEEDS HELPING IN BEEF WASTE RECLAMATION KEYWORDS ARIZONA CATTLE FEEDS PROTEINS |
| 400 | 72 | 2240 | FEEDS | GENERAL ELECTRIC TO RECYCLE BEEF MANURE INTO PROTEIN FEED AT NEW ARIZONA PLANT KEYWORD |
| 400 | 75 | 2251 | FEEDS | FERTILIZER FEED VALUE OF SWINE WASTES DETAILED KEYWORDS RECYCLING FERTILIZERS FEEDS SW |
| 100 | 67 | 2264 | FEEDS | LARVICIDAL ACTIVITY TO FLIES OF MANURE FROM CHICKS ADMINISTERED INSECTICIDE TREATED FEE |
| 400 | 73 | 2266 | FEEDS | VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY KEYWORDS FEEDS POULTRY ENERGY |
| 300 | 65 | 2267 | FEEDS | OBSERVATIONS ON THE NUTRITIVE VALUE OF CHICKEN MANURE FOR CATTLE KEYWORDS FEEDS NUTRI |
| 400 | 72 | 2273 | FEEDS | PROGRESS REPORTED IN HANDLING ANIMAL WASTES RECYCLING IN FEED KEYWORDS RECYCLING FEED |
| 400 | 71 | 2274 | FEEDS | FEEDING WASTES KEYWORDS FEEDS NUTRIENTS PERFORMANCE DRIED-SWINE-FECES DEHYDRATED-POUL |
| 400 | 71 | 2275 | FEEDS | CATTLE AS AN ECONOMIC BASE FOR AN ECOLOGICAL LOOP KEYWORDS CATTLE ECONOMICS FEEDLOTS |
| 200 | 73 | 2278 | FEEDS | CONVERTING SWINE WASTE INTO A NUTRIENT SOURCE FOR SWINE KEYWORDS RECYCLING FEEDS NUTRI |
| 200 | 72 | 2279 | FEEDS | NUTRIENT RECYCLING-MODERN ENERGY MANAGEMENT KEYWORDS NUTRIENTS RECYCLING ENERGY INCINE |
| 400 | 73 | 2287 | FEEDS | DIGESTIBILITY OF PROCESSED FEEDLOT MANURE KEYWORDS FEEDS CATTLE SHEEP PROTEINS PERFO |
| 400 | 72 | 2289 | FEEDS | MOLASSES FROM MANURE KEYWORDS FEEDS SLUDGE PROTEINS MANURE MOLASSES SULPHUR-DIOXIDE |
| 400 | 70 | 2291 | FEEDS | FLY PUPAE HIGH QUALITY PROTEIN SUPPLEMENT KEYWORDS FEEDS PROTEINS FERTILIZERS FLY-PU |
| 400 | 71 | 2295 | FEEDS | POULTRY MANURE DRIED WITH MICROWAVES KEYWORDS POULTRY DRYING MICROWAVES COSTS FEEDS F |
| 400 | 72 | 2298 | FEEDS | DRIED POULTRY WASTE AS FEED KEYWORDS FEEDS DRYING COSTS PROTEINS ECONOMICS DRIED-POUL |
| 400 | 72 | 2305 | FEEDS | PROCESSED POULTRY MANURE AS A FEEDSTUFF KEYWORDS POULTRY PERFORMANCE PHOSPHORUS AMIN |
| 400 | 75 | 2322 | FEEDS | NEW MANURE CONVERSION PLANT OPENED KEYWORDS RECYCLING FERTILIZERS FEEDS AEROBIC-DIGES |
| 100 | 73 | 2325 | FEEDS | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 100 | 73 | 2348 | FEEDS | ULTIMATE IN RECYCLING KEYWORDS RECYCLING FEEDS RECLAMATION ECONOMICS FEEDLOTS CHEMICA |
| 300 | 72 | 2371 | FEEDS | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PHOS |
| 300 | 72 | 2374 | FEEDS | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 700 | 72 | 2390 | FEEDS | CATTLE FEEDLOT WASTEWATER SALINITY KEYWORDS FEEDLOTS CATTLE WASTE-WATER-POLLUTION SAL |
| 200 | 70 | 2391 | FEEDS | REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION KEYWORDS RE |
| 200 | 70 | 2397 | FEEDS | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 100 | 48 | 2400 | FEEDS | RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE KEYWORDS FARM-WAST |
| 100 | 75 | 2419 | FEEDS | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 400 | 67 | 2420 | FEEDS | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 300 | 74 | 2452 | FEEDS | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 200 | 74 | 2457 | FEEDS | PROCEEDINGS OF SYMPOSIUM ON THE CONVERSION OF POULTRY WASTE TO ENERGY FEED OR FERTILIZE |
| 200 | 74 | 2459 | FEEDS | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 200 | 74 | 2460 | FEEDS | MARKETING CONVERTED MANURE KEYWORDS MARKETING FERTILIZERS FEEDS COSTS CALIFORNIA IOWA |
| 400 | 75 | 2512 | FEEDS | INFLUENCE OF FEEDING DEHYDRATED POULTRY WASTE ON BROILER GROWTH AND MEAT FLAVOR AND COM |
| 100 | 62 | 2535 | FEEDS | FEEDING POTENTIAL OF RECLAIMED FECAL RESIDUE KEYWORDS FEEDS CATTLE PERFORMANCE REFEED |
| 100 | 74 | 2541 | FEEDS | RECOVERING PROTEIN FROM DAIRY CATTLE WASTES KEYWORDS PROTEINS DAIRY-INDUSTRY SEPARATIO |
| 200 | 73 | 2548 | FEEDS | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUT |
| 300 | 65 | 2558 | FEEDS | CHICKEN LITTER AS A SUPPLEMENT IN WINTERING BEEF COWS AND CALVES ON PASTURE KEYWORDS |
| 400 | 75 | 2560 | FEEDS | COLORADO DPW PROCESSING FIRM FINDS READY MARKET AS BOTH FEED FERTILIZER KEYWORDS COLO |
| 200 | 75 | 2641 | FEEDS | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 200 | 75 | 2643 | FEEDS | RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED KEYWORDS AEROBIC-TREATMENT SLURR |
| 200 | 75 | 2645 | FEEDS | NUTRITIONAL PATHOLOGICAL AND PARASITOLOGICAL EFFECTS OF FEEDING FEEDLOT WASTE TO BEEF C |
| 200 | 75 | 2647 | FEEDS | NUTRITIONAL PROPERTIES OF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS KEYWORDS NUTR |
| 200 | 75 | 2652 | FEEDS | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2653 | FEEDS | CONVERSION OF ANIMAL WASTES TO FEED SUPPLEMENTS VIA THE ORGANIFORM PROCESS KEYWORDS O |
| 200 | 75 | 2682 | FEEDS | INFLUENCE OF ANTIBIOTICS AND GROWTH PROMOTING FEED ADDITIVES ON THE MANURING EFFECT OF |
| 200 | 75 | 2686 | FEEDS | PARTICLE SIZE DISTRIBUTION OF LIVESTOCK WASTES KEYWORDS SEPARATION-TECHNIQUES FEEDS VA |
| 400 | 64 | 2793 | FEEDS | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 100 | 72 | 2801 | FEEDS | RESEARCH AND TECHNOLOGY KEYWORDS RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 100 | 72 | 2804 | FEEDS | REMOVING THE SMELL FROM MANURE KEYWORDS POULTRY FEEDS DRYING AFTER-BURNER ODOR-REMOVA |
| 400 | 72 | 2805 | FEEDS | FEEDLOT WASTE USABLE KEYWORDS FEEDLOTS RECYCLING FEEDS PERFORMANCE FRACTIONATION BUIL |
| 100 | 71 | 2809 | FEEDS | FLAVOUR OF BEEF FED ON DRIED POULTRY WASTE KEYWORDS CATTLE FEEDS DRIED-POULTRY-WASTE |
| 400 | 75 | 2814 | FEEDS | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 200 | 75 | 2658 | FEED | CHARACTERIZATION OF METHANE PRODUCTION FROM POULTRY MANURE KEYWORDS METHANE ANAEROBIC- |
| 100 | 60 | 1677 | FEED-ADDITIVES | FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES KEYWORDS FEED-ADDIT |
| 300 | 73 | 1851 | FEED-ADDITIVES | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 100 | 70 | 2520 | FEED-ADDITIVES | POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANU |
| 400 | 74 | 1771 | FEED-CONVERSIONS | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 200 | 73 | 2548 | FEED-CONVERSION | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUT |
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| 400 | 73 | 1768 | FERMENTATION | IS TOTAL RECYCLING OF HEN MANURE POSSIBLE KEYWORDS POULTRY RECYCLING FERMENTATION DIG |
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| 400 | 72 | 1939 | FERMENTATION | WASTE CONVERSION UNIT DEVELOPED KEYWORDS FEEDS METHANE FERMENTATION ANAEROBIC-CONDITI |
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| 100 | 74 | 2802 | FERTILIZERS | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 100 | 72 | 2811 | FERTILIZERS | THE USE OF ANIMAL WASTES ON FERTILIZER KEYWORDS FERTILIZERS IRRIGATION ANIMAL-WASTES |
| 200 | 75 | 2590 | FERTILIZER | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 200 | 74 | 2010 | FERTILIZER-TAXESZW | AN ECONOMIC ANALYSIS OF POLICIES TO CONTROL NUTRIENT AND SOIL LOSSES FROM A SMALL WATER |
| 100 | 63 | 2581 | FERTILIZER-VALUE | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 400 | 73 | 1820 | FESCUES | GRASS FILTER SYSTEMS ANOTHER NEW RUNOFF CONTROL METHOD KEYWORDS WASTE-TREATMENT WASTE- |
| 200 | 75 | 2664 | FESCUES | LONG TERM BROILER LITTER FERTILIZATICN OF TALL FESCUE PASTURES AND HEALTH AND PERFORMAN |
| 200 | 75 | 2665 | FESCUES | MANURE FROM CAGED HENS EVALUATED ON FESCUE PASTURE KEYWORDS POULTRY FESCUES CROP-RESPO |
| 700 | 74 | 2774 | FESCUES | EFFECTS OF OVERLOADING SWINE EFFLUENT ON TALL FESCUE REED CANARYGRASS AND CORN KEYWORD |
| 400 | 73 | 1946 | FIBER | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 400 | 74 | 2172 | FIBER | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
| 200 | 75 | 2646 | FIBER | MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE |
| 600 | 74 | 1744 | FIELD-PERFORMANCE | FIELD PERFORMANCE OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS KEYWORDS CATTLE WAS |
| 200 | 75 | 2661 | FIELD-SINK | DIRECT LAND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF NUTRIENTS LAND-DI |
| 200 | 63 | 2159 | FIELD-SPREADING | PROGRESS REPORT ON MANURE HARVESTING KEYWORDS POULTRY LIQUID-WASTES WASTE-STORAGE WAS |
| 200 | 75 | 2714 | FIELD-TRANSPORTS | PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS KEYWORDS E |
| 200 | 75 | 2657 | FILLER | PRODUCT APPLICATIONS OF TREATED LIVESTOCK WASTE KEYWORDS RECYCLING PIGMENTS FEEDLOTS C |
| 700 | 71 | 2780 | FILTERING | AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS KEYWORDS ODOR CONFINEMENT-PENS F |
| 600 | 72 | 1875 | FILTERS | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 100 | 69 | 1659 | FILTRATION | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 600 | 71 | 1718 | FILTRATION | SYSTEM COMPONENTS TO SEPARATE SOLIDS AND LIQUIDS KEYWORDS SOLID-WASTES LIQUID-WASTES |
| 600 | 72 | 1875 | FILTRATION | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 100 | 71 | 2241 | FILTRATION | THE PERFORMANCE OF AN EXPERIMENTAL HIGH RATE BIOLOGICAL FILTRATION TOWER WHEN TREATING |
| 600 | 72 | 2262 | FILTRATION | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR |
| 700 | 72 | 2316 | FILTRATION | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 400 | 73 | 2429 | FILTRATION | RACEWAYS-EXOTIC SPECIES MOST AFFECTED BY PROPOSED EPA DISCHARGE PERMITS KEYWORDS REGU |
| 100 | 74 | 2775 | FILTRATION | EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO |
| 300 | 71 | 2196 | FINANCIAL-ASSISTAN | FEEDLOT WASTE MANAGEMENT-WHY AND HOW KEYWORDS FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON |
| 300 | 69 | 2078 | FINES | WATER POLLUTION LAWS AND REGULATIONS KEYWORDS WATER-POLLUTION REGULATION MISSOURI PER |
| 200 | 75 | 2643 | FINISHING-RATIONS | RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED KEYWORDS AEROBIC-TREATMENT SLURR |
| 300 | 72 | 2373 | FINISHING-STEERS | FEEDING VALUE OF CORN RECLAIMED FROM AN OXIDATION DITCH AND THE INFLUENCE OF ADDING WAT |
| 600 | 71 | 1715 | FISHFILL | THE STATE AND REGIONAL SITUATION KEYWORDS FEEDLOTS CONFINEMENT-PENS FARM-WASTES LIVES |
| 100 | 72 | 2112 | FISH | SHORT CUTS FROM MUCK TO MEALS KEYWORDS FEEDS RECLAMATION EFFLUENT FISH ALGAE MOLLUSK |
| 200 | 70 | 2397 | FISH | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 200 | 73 | 2440 | FISH | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
| 100 | 71 | 2570 | FISH | BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN KEYWORDS MICROORGANISMS TOXICITY FEEDLOT |
| 700 | 74 | 2766 | FISH | AQUATIC ECOLOGY OF SWINE WASTE LAGOONS BEFORE AND AFTER ARTIFICIAL AERATION KEYWORDS |
| 100 | 73 | 2226 | FISH-BEHAVIOR | INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH LEPOMI |
| 200 | 75 | 2683 | FISH-DIETS | OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR L AND EUGLENA SP KEYWORDS |
| 400 | 74 | 1626 | FISH-FARMING | MANURE HANDLING SYSTEMS FOR THE FUTURE KEYWORDS MANURE WASTE-HANDLING RECYCLING LAGOO |
| 600 | 74 | 1749 | FISH-FARMING | A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH PONDS KEYWORDS EFFLUENT F |
| 300 | 74 | 1782 | FISH-FARMING | POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS KEYWORDS FISH-FARMING |
| 600 | 72 | 1875 | FISH-FARMING | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 300 | 74 | 1914 | FISH-FARMING | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE WA |
| 600 | 72 | 1995 | FISH-FARMING | A TWO CROP FISH PRODUCTION SYSTEM KEYWORDS FISH-FARMING FISH-MANAGEMENT FISH-HARVEST |
| 400 | 74 | 2232 | FISH-FARMING | EPA AND THE FISH FARMER KEYWORDS FISH-FARMING REGULATIONS EFFLUENT PONDS SUSPENDED-S |
| 100 | 74 | 2404 | FISH-FARMING | CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH KEYWORDS |
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100 72 2193  FISH-HATCHERIES     TAKING CARE OF WASTES FROM THE TROUT FARM  KEYWORDS  FISH-HATCHERIES TROUT WATER-POLLUT
300 72 2090  FISH-KILLS          EUTROPHICATION IN THE GREAT PLAINS  KEYWORDS  EUTROPHICATION GREAT-PLAINS WATER-POLLUTI
200 69 2383  FISH-KILLS          ECONOMIC ASPECTS OF FEEDLOT WASTE POLLUTION  KEYWORDS ECONOMICS FEEDLOTS FARM-WASTES ST
600 72 1875  FISH-MANAGEMENT     AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS
600 72 1995  FISH-MANAGEMENT     A TWO CROP FISH PRODUCTION SYSTEM  KEYWORDS  FISH-FARMING FISH-MANAGEMENT FISH-HARVEST
100 74 2404  FISH-MANAGEMENT     CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH  KEYWORDS
300 74 1914  FISH-NUTRITION      PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING  KEYWORDS  AQUACULTURE WA
200 75 2683  FISH-PRODUCTION     OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR  L AND EUGLENA SP  KEYWORDS
600 72 1875  FISH-TOXINS         AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS
100 72 2193  FISH-WASTES         TAKING CARE OF WASTES FROM THE TROUT FARM  KEYWORDS  FISH-HATCHERIES TROUT WATER-POLLUT
700 67 2234  FIXED-SOLIDS        AEROBIC DIGESTION OF CATTLE WASTE  KEYWORDS  FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA
100 75 2543  FLAME-IONIZATION-D  METHODS FOR MEASURING SHORT CHAIN FATTY ACIDS AND AMMONIA FROM ANIMAL WASTES  KEYWORDS
300 71 2286  FLAME-PHOTOMETRY    IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS  KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE
200 75 2721  FLASH-TYPE-DRYER    IN-HOUSE HANDLING AND DEHYDRATION OF POULTRY MANURE FROM A  CAGED LAYER OPERATION A PRO
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100 71 2809  FLAVOR              FLAVOUR OF BEEF FED ON DRIED POULTRY WASTE  KEYWORDS  CATTLE  FEEDS DRIED-POULTRY-WASTE
300 64 1631  FLIES               THEORETICAL CONSIDERATIONS OF ANAEROBIC LAGOONS FOR POULTRY WASTES  KEYWORDS  ANAEROBIC
100 61 1669  FLIES               TOXICITY TO FLY LARVAE OF THE FECES OF INSECTICIDE FED CATTLE  KEYWORDS  TOXICITY CATTL
100 61 1670  FLIES               TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE FED CATTLE  KEYWORD
100 60 1677  FLIES               FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES  KEYWORDS  FEED-ADDIT
700 71 1688  FLIES               THE AEROBIC DECOMPOSITION OF SOLID BEEF CATTLE FEEDLOT WASTE  KEYWORDS  AEROBIC-TREATME
600 72 1752  FLIES               ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE  KEYWORDS  AERATION LARVAE F
300 73 1764  FLIES               DAIRY WASTE MANAGEMENT  KEYWORDS  WASTE-MANAGEMENT DAIRY-INDUSTRY CATTLE WATER-POLLUTIO
100 70 1823  FLIES               GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE  KEYWORDS  FEEDS ADD
200 71 1969  FLIES               WHAT OUR MILK MARKETS REQUIRE  KEYWORDS  MILK WASTE-DISPOSAL REGULATION DAIRY-INDUSTRY
200 71 1973  FLIES               FLIES IN RELATION TO MANURE HANDLING  KEYWORDS  WASTE-STORAGE DAIRY-INDUSTRY FLIES MANU
200 63 2154  FLIES               WASTE MANAGEMENT PROBLEMS ON THE FARM  KEYWORDS  POULTRY SPREADING SPRAYING HYDRAULIC-C
200 63 2157  FLIES               INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL  KEYWORDS  LAGOONS POULTRY WASTE-DISPOSAL OD
200 63 2163  FLIES               PUBLIC HEALTH ASPECTS OF POULTRY WASTE MANAGEMENT  KEYWORDS PUBLIC-HEALTH POULTRY COSTS
200 63 2164  FLIES               SANITARY LANDFILLING OF POULTRY WASTES  KEYWORDS  POULTRY SOLID-WASTES COSTS MANURE SAN
100 73 2169  FLIES               AGRICULTURAL SANITATION OF LIVESTOCK MANURES FOR CONTROL OF FLIES ODORS AND DUSTS  KEYW
400 71 2237  FLIES               COMPOSTING POULTRY MANURE IN DEEP PITS  KEYWORDS  COMPOSTING POULTRY WASTE-STORAGE ODOR
400 72 2306  FLIES               HOW NUTTING PRE-DRIES MANURE IN DEEP-PIT HOUSE  KEYWORDS POULTRY DRYING MOISTURE-CONTEN
300    2496  FLIES               KSU AEROBIC SWINE WASTE HANDLING SYSTEM-6 YEARS OF PROBLEMS AND PROGRESS  KEYWORDS  KAN
300 74 2555  FLIES               TWO TYPES OF DIGESTERS UNDER STUDY AT MSU-ANIMAL WASTE MANAGEMENT  KEYWORDS  AEROBIC-TR
100 71 2570  FLIES               BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN  KEYWORDS MICROORGANISMS TOXICITY FEEDLOT
400 71 2572  FLIES               THE DRY DEEP PIT SYSTEM  KEYWORDS  POULTRY ODOR WATER-POLLUTION VENTILATION DEEP-PITS F
400 72 2297  FLOATING-AERATORS   MANURE HOLDING POND ODOR CONTROL  KEYWORDS  AERATION SIZE MANURE-HOLDING-POND ODOR-CONT
200 75 2639  FLOCCULANTS         A PIG SLURRY TREATMENT SYSTEM BASED ON SEPARATION BEFORE AEROBIC TREATMENT AND SLUDGE D
600 74 1748  FLOCCULATING-AGENT  FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS  FLOCCULATION CATTLE FL
700 65 1666  FLOCCULATION        PERFORMANCE OF A CAGE RCTOR IN AN OXIDATION DITCH  KEYWORDS OXIDATION-DITCH PERFORMANCE
600 74 1748  FLOCCULATION        FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS  FLOCCULATION CATTLE FL
700 73 2061  FLOCCULATION        BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF  KEYWORDS  BIOLOGICAL-TREATMENT AGRICULTURAL-RUN
100 69 2380  FLOCCULATION        BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS  KEYWORDS  WAST
400 74 1917  FLOOD-CONTROL       DO FLUMES REALLY WORK  KEYWORDS  FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES
300 73 2096  FLOORS              SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING  KEYWORDS  WASTE-DISPOSAL SLABS COSTS ODORS LA
[illegible] 74 2118  FLOORS      FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO
300 [illegible] 2368  FLOORS     FINISHING YEARLINGS IN INSULATED HOUSING EQUIPPED WITH AN OXIDATION DITCH WASTE DISPOSA
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300 74 2118  FLOOR-SCRAPER       FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO
600 71 1726  FLOOR-TYPES         EFFECT OF HOUSED CONFINEMENT ON ANIMAL PERFORMANCE  KEYWORDS  CONFINEMENT-PENS CATTLE P
700 72 2127  FLORICA             SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS  KEYWORDS  SOI
400 74 2172  FLORICA             RECYCLED WASTE IN FEEDS DESCRIBED  KEYWORDS  RECYCLING FARM-WASTES FEEDS CATTLE POULTRY
200 73 2478  FLOTATION           SOLIDS SEPARATION  KEYWORDS  SEPARATION-TECHNIQUES SOLID-WASTES SLURRIES SETTLING-BASIN
400 70 2291  FLOTATION-PROCESS   FLY PUPAE HIGH QUALITY PROTEIN SUPPLEMENT  KEYWORDS  FEEDS  PROTEINS FERTILIZERS FLY-PU
100 73 1793  FLOW                DISPERSION DURING FLOW IN POROUS MEDIA WITH BILINEAR ABSORPTION  KEYWORDS  DISPERSION F
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200 73 2437  FLOW-CHARACTERISTI  OXYGENATION AND FLOW CHARACTERISTICS OF MECHANICAL AERATORS KEYWORDS  AERATION OXYGENAT
700 72 2127  FLOW-RATES          SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS  KEYWORDS  SOI
400 75 2341  FLOW-RATE           MOST FLUME FLOORS SHORT ON ENGINEERING  KEYWORDS  SAFETY-FACTOR FLOW-RATE WASTE-DILUTIO
600 72 1993  FLOW-RATIO          STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES  KEYWORD
200 74 2185  FLOW-SHEET          PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR
200 71 1964  FLOW-SYSTEM         MOVEMENT OF GROUND WATER  KEYWORDS  GROUNDWATER-POLLUTION MOVEMENT WASTE-DISPOSAL ANIMA
700 68 2310  FLOW-VELOCITIES     A MODEL STUDY OF FLOW VELOCITIES IN AN OXIDATION DITCH KEYWORDS  MODEL-STUDIES DESIGN O
100 73 1660  FLUCTUATIONS        FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAM
300 74 1900  FLUIDIZED-BED-REAC  CONVERSION OF CATTLE FEEDLOT WASTES TO AMMONIA SYNTHESIS GAS  KEYWORDS  CATTLE FEEDLOTS
400 74 1917  FLUMES              DO FLUMES REALLY WORK  KEYWORDS  FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES
400 74 2048  FLUMES              CONVENTIONAL CONFINEMENT OF FLUME  KEYWORDS  CONFINEMENT-PENS FLUMES COSTS PERFORMANCE
200 73 2481  FLUMES              FLUSH GUTTER SYSTEMS-CURRENT IOWA INSTALLATIONS  KEYWORDS IOWA HYDRAULIC-SYSTEMS ANAERO
200 75 2702  FLUMES              AN ECONOMIC AND MANAGERIAL EVALUATION OF MANURE FLUMING AND LAND APPLICATION SYSTEMS  K
200 74 2466  FLUME               HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE  KEYWORDS  CONFINEMENT-PENS DESIGN
400 75 2341  FLUME-FLOORS        MOST FLUME FLOORS SHORT ON ENGINEERING  KEYWORDS  SAFETY-FACTOR FLOW-RATE WASTE-DILUTIO
400 71 1641  FLUSHING            TEST SWINE WASTE DISPOSAL SYSTEMS  KEYWORDS  SWINE WASTE-DISPOSAL TESTING WATER-POLLUTI
400 74 1917  FLUSHING            DO FLUMES REALLY WORK  KEYWORDS  FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES
400 74 1994  FLUSHING            THIS PARLOR MAKES USE OF NEW IDEAS  KEYWORDS  DAIRY-INDUSTRY DESIGN MONTANA ODOR VENTIL
400 74 2048  FLUSHING            CONVENTIONAL CONFINEMENT OF FLUME  KEYWORDS  CONFINEMENT-PENS FLUMES COSTS PERFORMANCE
200 74 2150  FLUSHING            FLUSHING SWINE WASTE  KEYWORDS  AERATION RECYCLING ODOR COSTS SWINE FLUSHING SLOTTED-FL
400 75 2171  FLUSHING            SLICK DISPOSAL SETUP DAIRYMAN DESIGNED IT  KEYWORDS  WASTE-DISPOSAL LAGOONS WATER DAIRY
600 64 2201  FLUSHING            HOW ARE LAGOONS WORKING ON HOG FARMS  KEYWORDS  LAGOONS DESIGN WASTE-DISPOSAL CONFINEME
600 67 2205  FLUSHING            THE AMELIORATION OF ODOUR AND SOCIAL BEHAVIOUR IN,TOGETHER  WITH THE POLLUTION REDUCTIO
400 72 2290  FLUSHING            NEW WASTE TREATMENT SYSTEM IS USED FOR HOGS  KEYWORDS WASTE-TREATMENT SEPARATION-TECHNI
200 73 2432  FLUSHING            LIVESTOCK WASTE MANAGEMENT CONFERENCE  KEYWORDS  LIVESTOCK  ILLINOIS LEGAL-ASPECTS FEED
200 74 2466  FLUSHING            HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE  KEYWORDS  CONFINEMENT-PENS DESIGN
200 73 2472  FLUSHING            MIDWEST LIVESTOCK WASTE MANAGEMENT CONFERENCE  KEYWORDS FEEDLOTS HYDROLOGY DESIGN CONFI
200 73 2474  FLUSHING            CRITERIA FOR THE SELECTION OF A LIVESTOCK WASTE TREATMENT AND HANDLING SYSTEM  KEYWORDS
200 73 2482  FLUSHING            HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE  KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES
200 73 2484  FLUSHING            RECIRCULATION EQUIPMENT DESIGN AND SELECTION  KEYWORDS EQUIPMENT DESIGN HYDRAULIC-TRANS
200 75 2616  FLUSHING            MILKING CENTER WASTE MANAGEMENT  KEYWORDS  DAIRY-INDUSTRY RECYCLING IRRIGATION EFFLUENT
300 74 1891  FLUSHING-GUTTER     A WASTE TREATMENT SYSTEM FOR CONFINED HOG RAISING OPERATIONS  KEYWORDS  SWINE WASTE-TRE
200 75 2612  FLUSHING-GUTTER     OPERATION OF A BEEF MANURE FLUSHING SYSTEM IN A COLD CLIMATE KEYWORDS  CONFINEMENT-PENS
200 75 2684  FLUSHING-GUTTER-SY  SWINE WASTE LAGOONS AS POTENTIAL DISEASE RESERVOIRS  KEYWORDS  LAGOONS DISEASES PATHOGE
200 74 2136  FLUSHING-SYSTEMS    ANIMAL WASTE SYSTEMS  KEYWORDS  FEEDLOTS CONFINEMENT-PENS MICHIGAN WASTE-STORAGE WASTE-
200 71 1976  FLUSHING-SYSTEM     RESEARCH PROGRESS IN MANURE HANDLING AND TREATMENT SYSTEMS  FOR LIVESTOCK  KEYWORDS  WA
200 74 2463  FLUSH-FLUME-SYSTEM  BEEF IN CONFINEMENT WORKSHOP  KEYWORDS  FEEDLOTS CONFINEMENT-PENS CATTLE LEGAL-ASPECTS
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200 73 2481  FLUSH-GUTTER-SYSTE  FLUSH GUTTER SYSTEMS-CURRENT IOWA INSTALLATIONS  KEYWORDS IOWA HYDRAULIC-SYSTEMS ANAERO
400 73 1817  FLUSH-SYSTEM        FLUSH SYSTEM CUTS CONFINEMENT COSTS  KEYWORDS  CONFINEMENT-PENS CATTLE COSTS FLUSH-SYST
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| 100 | 70 | 2794 | FLY-ASH | SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT KEYWORDS POULTRY PORTLAND-CEMENTS FLY-A |
| 100 | 73 | 2218 | FLY-BREEDING | DESIGN OF SOLID MANURE STORAGE FOR DAIRY HERDS KEYWORDS DESIGN WASTE-STORAGE SOLID-WAS |
| 300 | 72 | 1647 | FLY-CCNTROL | HOUSE FLY CONTROL IN CAGED LAYER HOUSES KEYWORDS LARVAE FLY-CONTROL CAGED-LAYERS-HOUS |
| 200 | 64 | 1700 | FLY-CCNTROL | HYDRAULIC MANURE SYSTEMS KEYWORDS HYDRAULICS WASTE-HANDLING ODOR DESIGN CLEANING LIQU |
| 100 | 65 | 1750 | FLY-CCNTROL | COMPARATIVE EFFECTIVENESS AND PERSISTENCE OF CERTAIN INSECTICIDES IN POULTRY DROPPINGS |
| 400 | 74 | 1810 | FLY-CCNTROL | NC CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 400 | 74 | 1827 | FLY-CCNTROL | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AER |
| 100 | 70 | 1853 | FLY-CCNTROL | INTEGRATED FLY CONTRCL PROGRAM FOR CAGED POULTRY HOUSES KEYWORDS FLY-CONTROL CAGED-POU |
| 400 | 73 | 1922 | FLY-CCNTROL | KAOLIN RESULTS IN DRIER DROPPINGS KEYWORDS POULTRY ADDITIVES EXCRETA KAOLIN FLY-CONTR |
| 200 | 69 | 1981 | FLY-CCNTROL | DEHYDRATION AN ECONOMICAL SOLUTION TC POULTRY MANURE PROBLEMS KEYWORDS DEHYDRATION EC |
| 400 | 71 | 2083 | FLY-CCNTRCL | DO MANURE STACKS ADD TO FLY CONTROL PROBLEMS KEYWORDS BREEDING DAIRY-INDUSTRY FLY-CONT |
| 300 | 72 | 2268 | FLY-CCNTROL | FLY CONTRCL CN POULTRY FARMS KEYWORDS INSECTICIDES FLY-CONTROL SANITATION OPEN-FLOOR- |
| 400 | 72 | 2303 | FLY-CCNTROL | CHICKENS CONTROL FLIES FROM MANURE STACK KEYWORDS POULTRY DAIRY-INDUSTRY FLY-CONTROL |
| 100 | 70 | 2520 | FLY-CCNTROL | POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANU |
| 300 | 75 | 2545 | FLY-CCNTROL | INTEGRATED FLY CONTROL CN POULTRY RANCHES KEYWCRDS PREDATORS SCAVENGERS POULTRY CALIFO |
| 200 | 75 | 2695 | FLY-CCNTROL | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WAST |
| 400 | 74 | 2094 | FLY-LARVAE | NEW ODOR CONTROL PRODUCT NOW AVAILABLE KEYWORDS ODOR CONTROL BACTERIA FEEDLOTS FARM-W |
| 100 | 73 | 2325 | FLY-LARVAE | FEEDING OF COUMAPHCS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 100 | 72 | 2359 | FLY-LARVAE | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITEC-STATES AEROBIC-TREATMENT POULTR |
| 200 | 70 | 2397 | FLY-LARVAE | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 100 | 73 | 1747 | FLY-PUPAE | FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS KEYWORDS DIETS POULTRY PROTEINS |
| 400 | 70 | 2291 | FLY-PUPAE | FLY PUPAE HIGH QUALITY PROTEIN SUPPLEMENT KEYWORDS FEEDS PROTEINS FERTILIZERS FLY-PU |
| 700 | 67 | 1651 | FOAMING | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 700 | 70 | 1736 | FOAMING | ODOR CONTROL AND DEGRADATION CF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 200 | 75 | 2637 | FOAMING | KSU AEROBIC SWINE WASTE HANDLING SYSTEM-SIX YEARS OF PROBLEMS AND PROGRESS KEYWORDS A |
| 300 | | 2496 | FOAM-CONTRCL | KSU AEROBIC SWINE WASTE HANDLING SYSTEM-6 YEARS CF PROBLEMS AND PROGRESS KEYWORDS KAN |
| 300 | 74 | 1627 | FOAM-SEPARATION | ANAEROBIC AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES KEYWORDS AEROBIC-TREATMENT A |
| 400 | 72 | 1842 | FOAM-SEPARATION | WLJ PREVIEWS FIRST COMMERCIAL MANURE SYSTEM KEYWORDS AEROBIC-TREATMENT LICOM-WASTE-TRE |
| 400 | 73 | 1632 | FCOC-ANC-DRUG-ADMI | FEEDING STEERS DPM KEYWORDS FEEDS POULTRY CATTLE PROTEINS PERFORMANCE DEHYDRATED-POUL |
| 400 | 75 | 2116 | FCCC-AND-DRUG-ADMI | FEED PRICES ENVIRONMENTAL LAWS HELP SALES OUTLOOK FCR DRYING EQUIPMENT DPW KEYWORDS E |
| 400 | 72 | 2273 | FCCC-AND-DRUG-ADMI | PROGRESS REPORTED IN HANDLING ANIMAL WASTES RECYCLING IN FEED KEYWORDS RECYCLING FEED |
| 400 | 72 | 2304 | FCOC-AND-DRUG-ADMI | DATA NEEDED ON SAFETY OF RECYCLING WASTE KEYWORDS RECYCLING PATHOGENIC-BACTERIA SAFET |
| 400 | 75 | 2345 | FCCC-ANC-DRUG-ACMI | RECYCLING NUTRIENTS FOR LIVESTOCK KEYWORDS RECYCLING POULTRY REGULATION CALIFORNIA MI |
| 100 | 75 | 2419 | FCOC-AND-DRUG-ADMI | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 200 | 74 | 2460 | FCOD-AND-DRUG-ADMI | MARKETING CONVERTED MANURE KEYWORDS MARKETING FERTILIZERS FEEDS COSTS CALIFORNIA IOWA |
| 200 | 74 | 2468 | FCOC-AND-DRUG-ADMI | RECYCLING ITS PROBLEMS AND CPPORTUNITIES KEYWORDS RECYCLING METHANE LAGOONS NUTRIENTS |
| 100 | 70 | 2763 | FCOD-INDUSTRY | ROLE OF THE DAIRY AND FEED INDUSTRY IN ENVIRONMENTAL POLLUTION CONTROL KEYWORDS DAIRY |
| 300 | 74 | 1914 | FCOD-PROCESSING-WA | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE WA |
| 500 | 74 | 2132 | FCOD-PROCESSING-WA | AGRICULTURAL WASTE MANAGEMENT-PRCBLEMS PROCESSES ANC APPROACHES KEYWORDS WASTE-TREATM |
| 300 | 73 | 1785 | FOOC-SUPPLY | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORCS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 300 | 64 | 1786 | FCRAGES | NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWORDS NITRATES NITRITES POLLUTANTS WATER |
| 200 | 75 | 2751 | FCRAGES | DISPOSAL CF DAIRY CATTLE MANURE ON SCIL KEYWORDS CAIRY-INDUSTRY CATTLE SOILS CROP-RES |
| 700 | 74 | 2774 | FCRAGES | EFFECTS OF OVERLOADING SWINE EFFLUENT ON TALL FESCUE REED CANARYGRASS AND CORN KEYWORD |
| 300 | 74 | 1619 | FORAGE-GRASSES | FERTILIZER VALUE OF DAIRY LOT MANURE KEYWORDS FERTILIZERS DAIRY-INDUSTRY CONFINEMENT- |
| 100 | 74 | 1821 | FORAGE-GRASSES | IRRIGATION OF PERENNIAL FORAGE CROPS WITH FEEDLOT RUNOFF KEYWORDS IRRIGATION AGRICULTU |
| 300 | 65 | 2377 | FCRAGE-RESPCNSE | BROILER LITTER AS A FERTILIZER KEYWORDS FERTILIZERS NUTRIENTS BROILER-LITTER LAND-DIS |
| 100 | 74 | 2491 | FORAGE-SORGHUM | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY C |
| 400 | 73 | 1633 | FCRAGE-YIELDS | FAST FLUSH SYSTEM KEYWCRDS FAST-FLUSH-SYSTEM CATTLE WASTE-TREATMENT WASTE-DISPCSAL FE |
| 400 | 73 | 2416 | FCRCED-CRYING | POULTRY MANURE COMPCSTING KEYWORDS AERATION FCRCED-DRYING THERMOPHILIC-BACTERIA MOIST |
| 100 | 71 | 1872 | FORESTRY | AGRICULTURE THE SEEDS OF A PROBLEM KEYWORDS AGRICULTURE FARM-WASTES FORESTRY WASTE-DI |
| 300 | 74 | 1860 | FORESTS | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 200 | 75 | 2674 | FOREST-BUFFER-ZONE | EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED |
| 200 | 74 | 2017 | FOREST-MANAGEMENT | EUROPEAN APPRCACHES TO THE CONTROL OF WATER POLLUTION PROBLEMS CAUSED BY AGRICULTURAL W |
| 400 | 71 | 2296 | FCREST-MANAGEMENT | FOREST LAND FOR MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL FOREST-MANAGEMENT NITROGEN LI |
| 300 | 73 | 1849 | FORMALDEHYDE-FLAKE | THE USE OF FORMALDEHYDE FLAKES AS AN ANTIMICROBIAL AGENT IN BUILT UP POULTRY LITTER KE |
| 300 | 73 | 1825 | FORMULATION | AREA NEEDED FOR LAND DISPOSAL CF BEEF AND SWINE WASTES KEYWORDS CATTLE SWINE WASTE-DIS |
| 200 | 75 | 2647 | FRACTIONATED-MANUR | NUTRITICNAL PROPERTIES CF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS KEYWORDS NUTR |
| 400 | 72 | 2805 | FRACTIONATICN | FEEDLOT WASTE USABLE KEYWORDS FEEDLCTS RECYCLING FEEDS PERFORMANCE FRACTIONATICN BUIL |
| 200 | 73 | 2476 | FREE-STALL | CONFINEMENT SYSTEMS AND MANURE MANAGEMENT-STATE CF THE ART KEYWORDS CONFINEMENT-PENS |
| 400 | 74 | 2417 | FREE-STALL-BARNS | SOLID WASTE HANDLING KEYWORDS SOLID-WASTES SLURRIES DAIRY-INDUSTRY WASTE-STORAGE STOR |
| 100 | 73 | 2514 | FREE-STALL-BARNS | DAIRY WASTE MANAGEMENT SYSTEMS KEYWCRDS DAIRY-INDUSTRY ODOR VENTILATION HOUSING STALL |
| 300 | 74 | 2118 | FREE-STALL-HOUSING | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 700 | 74 | 2362 | FROZEN-SOILS | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 300 | 73 | 1835 | FRUIT-AND-VEGETABL | STRUCTURES AND ENVIRONMENT HANDBOOK KEYWORDS PLANNING ENVIRONMENT WASTE-DISPOSAL DESI |
| 300 | 73 | 1622 | FUELS | THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS KEYWORDS RECYCLING QUALITATIVE-ORG |
| 400 | 74 | 1630 | FUELS | MANURE AS A FUEL KEYWORDS FUELS MANURE WASTE-TREATMENT WASTE-DISPOSAL COMPOSTING AGRI |
| 600 | 73 | 1746 | FUELS | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |
| 400 | 74 | 1769 | FUELS | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 400 | 74 | 1808 | FUELS | MONFORT FUELS FEEDLOT AND PLANT WITH MANURE KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA |
| 100 | 73 | 1833 | FUELS | AGRICULTURAL WASTES KEYWCRDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 400 | 73 | 1859 | FUELS | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 400 | 71 | 1937 | FUELS | WASTES MAY PROVIDE FUEL FOR HEATING KEYWORCS FUELS GASES ENERGY FEEDLOTS PYROLYSIS M |
| 600 | 74 | 2072 | FUELS | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 100 | 74 | 2075 | FUELS | FUEL FROM LIVESTOCK WASTES-AN ECONOMIC ANALYSIS KEYWCRDS FUELS ORGANIC-WASTES ECONOMIC |
| 100 | 74 | 2184 | FUELS | METHANE PRODUCTION FROM WASTE KEYWORDS METHANE METHANE-BACTERIA SEWAGE WASTE-TREATMEN |
| 300 | 72 | 2213 | FUELS | METHANE PRODUCTION FROM ANAEROBIC DIGESTION OF ANIMAL WASTES KEYWORDS METHANE ANIMAL- |
| 300 | 72 | 2313 | FUELS | FEEDLCT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 72 | 2314 | FUELS | FUEL FROM WASTES-A MINOR ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 300 | 74 | 2323 | FUELS | OKLAHOMA MANURE FOR MIDWEST METHANE KEYWORDS METHANE FUELS OKLAHOMA RECYCLING CATTLE |
| 400 | 74 | 2776 | FUELS | ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES KEYWORDS ENERGY FUE |
| 200 | 71 | 2785 | FUELS | AGRICULTURAL WASTES-AN ENERGY RESOURCE OF THE SEVENTIES KEYWORDS RECYCLING ENERGY FUEL |
| 100 | 72 | 2799 | FUELS | RETORTING FEEDLOT WASTES KEYWORDS FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO |
| 100 | 72 | 2801 | FUELS | RESEARCH AND TECHNCLOGY KEYWORDS RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 100 | 74 | 2802 | FUELS | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 200 | 75 | 2607 | FULLY-STEPPED-CAGE | IN-HOUSE MANURE DRYING-THE SLAT SYSTEM KEYWORDS DESIGN POULTRY DRYING ODOR VENTILATIO |
| 400 | 74 | 2041 | FUMIGATION | THE MANY ASPECTS OF SANITATION IN POULTRY DISEASE CCNTROL KEYWORDS ENVIRONMENTAL-SANIT |
| 300 | 64 | 1786 | FUMING-SILOS | NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWCRDS NITRATES NITRITES POLLUTANTS WATER |
| 100 | 72 | 1788 | FUNGI | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 200 | 75 | 2680 | FUNGI | A MYCOLOGICAL INVESTIGATION OF BEEF FEEDLOT MANURE IN A SEMIARID TEMPERATE CLIMATE KEY |
| 100 | 71 | 2767 | FUNGI | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 300 | 72 | 2367 | GAINS | A COMPARISON OF FIVE HOUSING SYSTEMS FOR FEEDLOT CATTLE KEYWORDS FEEDLOTS CONFINEMENT- |
| 300 | 72 | 2374 | GAINS | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 200 | 70 | 2391 | GARBAGE | REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION KEYWORDS RE |
| 100 | 70 | 1823 | GARDONA | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE KEYWORDS FEEDS ADD |
| 700 | 69 | 1650 | GASES | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN-D |
| 600 | 71 | 1720 | GASES | NATURE AND BEHAVIOR OF MANURE KEYWORDS WATER-POLLUTICN FEEDLOTS AGRICULTURAL-RUNOFF M |
| 700 | 64 | 1735 | GASES | ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING KEYWCRDS ODOR SWINE CONFINEMENT-HOUSING |
| 700 | 70 | 1736 | GASES | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 600 | 73 | 1746 | GASES | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |

# KEYWORD INDEX

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|---|---|---|---|---|
| 400 | 74 | 1765 | GASES | MANURE GASES KILL 25 HEAD IN OHIO KEYWORDS MANURE GASES CATTLE OHIO MORTALITY SLATTED |
| 700 | 68 | 1826 | GASES | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 200 | 74 | 1868 | GASES | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 300 | 74 | 1900 | GASES | CONVERSION OF CATTLE FEEDLOT WASTES TO AMMONIA SYNTHESIS GAS KEYWORDS CATTLE FEEDLOTS |
| 100 | 71 | 1904 | GASES | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 300 | 73 | 1907 | GASES | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 100 | 72 | 1913 | GASES | EFFECT OF SLOTTED FLOORS ON AIR FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILD |
| 200 | 71 | 1926 | GASES | FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS KEYWORDS LIQUID-W |
| 400 | 71 | 1937 | GASES | WASTES MAY PROVIDE FUEL FOR HEATING KEYWORDS FUELS GASES ENERGY FEEDLOTS PYROLYSIS R |
| 400 | 70 | 1947 | GASES | LITTLE POLLUTION FROM THIS FEEDLOT KEYWORDS FEEDLOTS NEBRASKA ANALYSIS NITRATES GASES |
| 600 | 74 | 2072 | GASES | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 100 | 74 | 2075 | GASES | FUEL FROM LIVESTOCK WASTES-AN ECONOMIC ANALYSIS KEYWORDS FUELS ORGANIC-WASTES ECONOMIC |
| 200 | 73 | 2101 | GASES | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 700 | 65 | 2120 | GASES | ANAEROBIC DIGESTION OF CHICKEN MANURE KEYWORDS ANAEROBIC-DIGESTION POULTRY MATHEMATIC |
| 500 | 74 | 2132 | GASES | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
| 200 | 63 | 2158 | GASES | DIGESTION OF FARM POULTRY WASTES KEYWORDS ANAEROBIC-DIGESTION POULTRY WASTE-TREATMENT |
| 200 | 72 | 2168 | GASES | THERMOCHEMICAL EVALUATION OF ANIMAL WASTE CONVERSION PROCESSES KEYWORDS RECYCLING GAS |
| 200 | 73 | 2180 | GASES | HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS KEYWORDS GASES RECYCLING CATTLE GU |
| 100 | 74 | 2184 | GASES | METHANE PRODUCTION FROM WASTE KEYWORDS METHANE METHANE-BACTERIA SEWAGE WASTE-TREATMEN |
| 700 | 65 | 2188 | GASES | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 100 | 71 | 2200 | GASES | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 | 69 | 2216 | GASES | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN- |
| 700 | 63 | 2233 | GASES | CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE KEYWORDS FARM-WASTES HOGS ANAE |
| 400 | 68 | 2247 | GASES | ANIMAL WASTE DISPOSAL METHODS-PRESENT AND FUTURE KEYWORDS ANIMAL-WASTES WASTE-DISPOSA |
| 100 | 74 | 2256 | GASES | DIURNAL FLUCTUATION AND MOVEMENT OF ATMOSPHERIC AMMONIA AND RELATED GASES FROM DAIRIES |
| 400 | 71 | 2271 | GASES | POULTRY HOUSES THAT MAKE GOOD NEIGHBORS KEYWORDS ODOR DUSTS VENTILATION AMMONIA GASES |
| 200 | 68 | 2282 | GASES | THEORY AND PRACTICE OF ANAEROBIC DIGESTERS AND LAGOONS KEYWORDS ANAEROBIC-DIGESTION LA |
| 700 | 71 | 2309 | GASES | IDENTIFICATION AND CONTROL OF CATTLE FEEDLOT ODORS KEYWORDS ODOR FEEDLOTS CATTLE GASE |
| 700 | 72 | 2315 | GASES | THE STRATIFICATION OF AN ANAEROBIC DAIRY MANURE LAGOON KEYWORDS DAIRY-INDUSTRY STRATIF |
| 400 | 61 | 2360 | GASES | MANURE SMELL FURNISHES FARMSTEADS POWER NEEDS KEYWORDS GASES FERTILIZERS ANAEROBIC-DIG |
| 200 | 73 | 2440 | GASES | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
| 400 | 75 | 2501 | GASES | MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS KEYWORDS RECYCLING BY-PRODUCTS FOOD |
| 400 | 74 | 2776 | GASES | ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES KEYWORDS ENERGY FUE |
| 200 | 71 | 2785 | GASES | AGRICULTURAL WASTES-AN ENERGY RESOURCE OF THE SEVENTIES KEYWORDS RECYCLING ENERGY FUEL |
| 100 | 71 | 2807 | GASES | INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIAL |
| 300 | 73 | 1907 | GASIFICATION | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 300 | 72 | 2313 | GASIFICATION | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 | 65 | 2450 | GASIFICATION | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION DESIGN HOGS TEMPERATUR |
| 400 | 74 | 2776 | GASIFICATION | ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES KEYWORDS ENERGY FUE |
| 600 | 69 | 1841 | GAS-CHROMATOGRAPHY | A PROCEDURE TO IDENTIFY MALODORS FROM ANIMAL WASTES KEYWORDS ODOR GAS-CHROMATOGRAPHY S |
| 700 | 72 | 2321 | GAS-CHROMATOGRAPHY | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 100 | 75 | 2543 | GAS-CHROMATOGRAPHY | METHODS FOR MEASURING SHORT CHAIN FATTY ACIDS AND AMMONIA FROM ANIMAL WASTES KEYWORDS |
| 300 | 73 | 1622 | GAS-CONDENSATION | THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS KEYWORDS RECYCLING QUALITATIVE-ORG |
| 100 | 73 | 2332 | GAS-LIQUID-CHROMAT | ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS KEYWORD |
| 700 | 63 | 2311 | GAS-PRODUCTION | CHARACTERISTICS AND TREATMENT OF WASTES FROM A CONFINEMENT HOG PRODUCTION UNIT KEYWOR |
| 300 | 74 | 2555 | GAS-PRODUCTION | TWO TYPES OF DIGESTERS UNDER STUDY AT MSU-ANIMAL WASTE MANAGEMENT KEYWORDS AEROBIC-TO |
| 100 | 74 | 2802 | GAS-PRODUCTION | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 100 | 72 | 1621 | GAS-WASHING-AND-SC | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 100 | 63 | 2581 | GAS-YIELD | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 200 | 73 | 2441 | GATED-PIPE | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 700 | 72 | 2321 | GC-CALIBRATION | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 400 | 74 | 1636 | GENERAL-ELECTRIC | MANURE IS FOOD FOR PROTEIN KEYWORDS MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE |
| 400 | 72 | 1819 | GENERAL-ELECTRIC | GE ENTERS MANURE RECYCLING RACE KEYWORDS MANURE FEEDLOTS RECYCLING FEEDS PROTEINS MA |
| 400 | 73 | 1858 | GENERAL-ELECTRIC | FERMENTATION HEADS FOR HIGHER PRODUCTIVITY KEYWORDS FERMENTATION RECYCLING WASTE-TREAT |
| 400 | 72 | 1945 | GENERAL-ELECTRIC | THIS PLANT WILL CONVERT WASTE INTO PROTEIN KEYWORDS FEEDS PROTEINS THERMOPHILIC-BACTE |
| 400 | 72 | 2240 | GENERAL-ELECTRIC | GENERAL ELECTRIC TO RECYCLE BEEF MANURE INTO PROTEIN FEED AT NEW ARIZONA PLANT KEYWORD |
| 100 | 72 | 2801 | GENERAL-ELECTRIC | RESEARCH AND TECHNOLOGY KEYWORDS RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 400 | 72 | 1940 | GENERATING-PLANT | WARM WATER STUDY KEYWORDS REGULATION FEEDS ALGAE FEEDLOTS GENERATING-PLANT WARM-WATER |
| 600 | | 2777 | GEOCHEMISTRY | GROUND WATER CONTAMINATION BY DISSOLVED NITRATE KEYWORDS NITRATES FERTILIZERS GEOCHEMI |
| 200 | 75 | 2600 | GEOGRAPHY | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |
| 200 | 71 | 1931 | GEOLOGY | EFFECT OF CATTLE FEEDLOT WASTES UPON GROUND WATER-A COMMENTARY KEYWORDS FEEDLOTS GROU |
| 600 | 74 | 2072 | GEORGIA | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 400 | 75 | 2353 | GEORGIA | POULTRY LITTERS VALUE AS FERTILIZER CITED BY GEORGIAN KEYWORDS POULTRY LITTER FERTILIZ |
| 400 | 69 | 2540 | GEORGIA | APPLY MORE NOT LESS POULTRY LITTER TO REDUCE POLLUTION KEYWORDS AGRICULTURAL-RUNOFF GR |
| 100 | 73 | 2121 | GERMINATION | EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTE |
| 700 | 74 | 2765 | GERMINATION | ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE ON THE FEEDLOT SOIL PROFILE |
| 300 | 74 | 2555 | GERMINATION-CUPS | TWO TYPES OF DIGESTERS UNDER STUDY AT MSU-ANIMAL WASTE MANAGEMENT KEYWORDS AEROBIC-TO |
| 100 | 71 | 2358 | GLAMORGAN | INDUSTRIAL WASTE AND AGRICULTURE IN GLAMORGAN KEYWORDS INDUSTRIAL-WASTES AGRICULTURE B |
| 100 | 74 | 2802 | GOBAR-GAS-PLANT | GOBAR GAS PLANTS PROMISES AND PROBLEMS KEYWORDS FUELS ANAEROBIC-DIGESTER ORGANIC-WAST |
| 400 | 72 | 2283 | GOVERNMENT-ASSISTA | COSTS OF CONTROLLING FEEDLOT SURFACE RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF COST |
| 200 | 74 | 2143 | GOVERNMENT-FINANCE | POLLUTION ABATEMENT ON FARMSTEADS KEYWORDS POLLUTION-ABATEMENT COSTS FARMS GOVERNMENT |
| 200 | 74 | 2031 | GRAIN-SORGHUM | EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFFLUENT ON CORN AND GRAIN SORGHUM KEYWORDS |
| 100 | 65 | 2423 | GRAIN-SORGHUM | VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL KEYWORDS NUTRIENTS NITROGEN PHOSPHORUS |
| 200 | 75 | 2660 | GRAIN-SORGHUM | RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE ON GRAIN SORGHUM YIELDS KEYWORDS FERTILIZE |
| 400 | 68 | 1884 | GRANTS | THE COWS VS THE SUBURBS KEYWORDS DAIRY-INDUSTRY COSTS RESEARCH-AND-DEVELOPMENT WATER- |
| 300 | 68 | 2220 | GRAPHICAL-PLOTS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 400 | 74 | 2093 | GRASSES | COMPOSTED CHICKEN LITTER SEEMS TO RECLAIM SALT DAMAGED LAND KEYWORDS SALTS RECLAMATIO |
| 100 | 74 | 2236 | GRASSES | USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL |
| 200 | 75 | 2667 | GRASSES | THE YIELD RESPONSE OF GRASS TO AEROBICALLY STABILIZED SWINE WASTE KEYWORDS CROP-RESPO |
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| 100 | 75 | 2544 | GRASS-TETANY | LAND DISPOSAL OF BROILER LITTER-CHANGES IN SOIL POTASSIUM CALCIUM AND MAGNESIUM KEYWOR |
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200 71 1975  HOLDING-TANKS        LIQUID MANURE HANDLING  KEYWORDS  LIQUID-WASTES WASTE-STORAGE LAGOONS WASTE-HANDLING HO
200 75 2637  HOLDING-TANKS        KSU AEROBIC SWINE WASTE HANDLING SYSTEM-SIX YEARS OF PROBLEMS AND PROGRESS  KEYWORDS  A
700 69 2225  HOLDING-TANK         AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON  THE AGITATION AND REMOVAL O
100 70 2786  HOLDING-TANK         TREATMENT AND DISPOSAL OF ANIMAL WASTES  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL ANIMA
200 75 2615  HOLLOW-PISTON-PUMP   LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES- EARTHEN BASINS  KEYWORDS  DAIRY-
300 72 2370  HOLSTEIN-STEERS      COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS
300 72 2372  HOLSTEIN-YEARLINGS   INFLUENCE OF AN ANTIBIOTIC ON THE PERFORMANCE OF YEARLING HOLSTEIN STEERS  KEYWORDS  AN
100 69 2808  HORMONAL-IMBALANCE   ABORTION IN CATTLE ASSOCIATED WITH THE FEEDING OF POULTRY LITTER  KEYWORDS  LITTER CATT
100 73 2354  HORN-FLIES           HORN FLIES STABLE FLIES AND HOUSE FLIES-DEVELOPMENT IN FECES OF BOVINES TREATED ORALLY
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200 70 2392  HORSES               A PERSPECTIVE FOR CONNECTICUT  KEYWORDS  CONNECTICUT POULTRY DAIRY-INDUSTRY AGRICULTURA
200 70 2391  HORTICULTURAL-WAST   REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION  KEYWORDS  RE
600 71 1726  HOUSED-CONFINEMENT   EFFECT OF HOUSED CONFINEMENT ON ANIMAL PERFORMANCE  KEYWORDS  CONFINEMENT-PENS CATTLE P
100 75 2456  HOUSEFLIES           WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE  KEY
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100 73 2354  HOUSE-FLIES          HORN FLIES STABLE FLIES AND HOUSE FLIES-DEVELOPMENT IN FECES OF BOVINES TREATED ORALLY
100 73 1801  HOUSE-FLY-LARVAE     ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE  K
700 67 1651  HOUSING              MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE  KEYWORDS
600 72 1886  HOUSING              SLOTTED FLOOR COLD CONFINEMENT BEEF CATTLE HOUSING  KEYWORDS  CATTLE DESIGN PERFORMANCE
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200 74 2135  HOUSING              AGRICULTURAL WASTE CONFERENCE  KEYWORDS  ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC
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| 200 | 73 | 2482 | HYDRAULIC-SYSTEMS | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 700 | 71 | 1609 | HYDRAULIC-TRANSPOR | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 600 | 71 | 1719 | HYDRAULIC-TRANSPOR | SWINE MANURE COLLECTION AND REMOVAL SYSTEMS KEYWORDS SWINE COLLECTION REMOVAL CONFINEM |
| 100 | 74 | 1855 | HYDRAULIC-TRANSPOR | A ROTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER KEYWORDS SOLID-WAST |
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| 400 | 75 | 2425 | HYDROCARBONS | UTILIZING WASTES IN ANIMAL FEEDS-A EUROPEAN OVERVIEW KEYWORDS RECYCLING ORGANIC-WASTE |
| 200 | 74 | 2459 | HYDROCARBONS | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 100 | 72 | 2800 | HYDROCARBONS | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 600 | 73 | 1746 | HYDROGASIFICATION | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |
| 300 | 73 | 1907 | HYDROGASIFICATION | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
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| 400 | 73 | 1859 | HYDROGENATION | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 100 | 72 | 2314 | HYDROGENATION | FUEL FROM WASTES-A PINCH ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 100 | 74 | 2047 | HYDROGEN | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 200 | 73 | 2180 | HYDROGEN | HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS KEYWORDS GASES RECYCLING CATTLE AU |
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| 700 | 73 | 1652 | HYDROGEN-ION-CONCE | DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS WASTE-TREATMENT AGR |
| 100 | 73 | 1832 | HYDROGEN-ION CONCE | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 700 | 71 | 1864 | HYDROGEN-ION-CONCE | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 100 | 72 | 2186 | HYDROGEN-ION-CONCE | HANDLING MILKING PARLOR WASTE KEYWORDS DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM |
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| 200 | 74 | 1988 | HYDROGEN-PEROXIDE | MODIFICATION AND ENZYMATIC HYDROLYSIS OF CATTLE FEEDLOT MANURE KEYWORDS FEEDLOTS CATT |
| 200 | 75 | 2698 | HYDROGEN-PEROXIDE | CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO REDUCE MALODORS KEYWORDS CHEMICAL-TREATME |
| 700 | 70 | 1736 | HYDROGEN-SULFIDE | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 100 | 71 | 1904 | HYDROGEN-SULFIDE | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 100 | 74 | 2045 | HYDROGEN-SULFIDE | CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN STORED DAIRY MANURE KEYWOR |
| 200 | 73 | 2101 | HYDROGEN-SULFIDE | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 200 | 74 | 2151 | HYDROGEN-SULFIDE | AGRICULTURAL POLLUTION CONTROL LABORATORY KEYWORDS BACTERIA HYDROGEN-SULFIDE METHANE |
| 700 | 65 | 2188 | HYDROGEN-SULFIDE | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 600 | 67 | 2198 | HYDROGEN-SULFIDE | STORAGE OF POULTRY MANURE WITH MINIMUM ODOR KEYWORDS WASTE-STORAGE POULTRY ODOR OXIDAT |
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| 200 | 75 | 2692 | HYDROGEN-SULFIDE | MANURE GASES AND AIR CURRENTS IN LIVESTOCK HOUSING KEYWORDS LIVESTOCK VENTILATION HYDR |
| 300 | 68 | 2220 | HYDROGRAPHS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 100 | 73 | 1664 | HYDROGRAPH-ANALYSI | A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED |
| 300 | 73 | 1784 | HYDROLOGIC-BUDGET | THE WATER BUDGET AND WASTE TREATMENT AT A MODERN DAIRY KEYWORDS DAIRY-INDUSTRY HYDROLO |
| 700 | 71 | 1761 | HYDROLOGIC-PROPERT | HYDROLOGIC AND WATER QUALITY CHARACTERISTICS OF BEEF FEEDLOT RUNOFF KEYWORDS HYDROLOG |
| 700 | 67 | 2228 | HYDROLOGIC-SOIL-CO | ANNUAL TOTALS AND TEMPORAL DISTRIBUTION OF CATTLE FEEDLOT RUNOFF IN KANSAS KEYWORDS A |
| 300 | 72 | 1628 | HYDROLOGY | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 300 | 73 | 1759 | HYDROLOGY | POLLUTION FROM ANIMAL FEEDLOTS KEYWORDS FEEDLOTS WATER-POLLUTION-SOURCES AGRICULTURAL |
| 700 | 67 | 1838 | HYDROLOGY | WATER POLLUTION POTENTIAL OF CATTLE FEEDLOT RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUN |
| 300 | 72 | 2086 | HYDROLOGY | HYDROLOGY AND CHARACTERISTICS OF FEEDLOT RUNOFF KEYWORDS HYDROLOGY FEEDLOTS AGRICULTUR |
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| 200 | 73 | 2472 | HYDROLOGY | MIDWEST LIVESTOCK WASTE MANAGEMENT CONFERENCE KEYWORDS FEEDLOTS HYDROLOGY DESIGN CONFI |
| 200 | 73 | 2473 | HYDROLOGY | HYDROLOGY OF OPEN FEEDLOTS IN THE CORNBELT KEYWORDS HYDROLOGY FEEDLOTS CORN-BELT RAINF |
| 100 | 74 | 2075 | HYDROLYSIS | FUEL FROM LIVESTOCK WASTES-AN ECONOMIC ANALYSIS KEYWORDS FUELS ORGANIC-WASTES ECONOMIC |
| 200 | 75 | 2681 | HYDROLYSIS | MODIFICATION AND ENZYMATIC HYDROLYSIS OF FEEDLOT WASTE KEYWORDS HYDROLYSIS FEEDLOTS NU |
| 200 | 75 | 2624 | HYDROPULPING | DAIRY WASTE FIBER-A BYPRODUCT WITH A FUTURE KEYWORDS DAIRY-INDUSTRY SEPARATION-TECHNIQ |
| 200 | 68 | 1642 | HYDROPONICS | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 600 | 72 | 1901 | HYDROPONICS | FACTORS WHICH INFLUENCE THE UTILIZATION OF ANIMAL EXCRETA EITHER DIRECTLY BY ANIMALS OR |
| 600 | 72 | 1875 | ICTALURUS-PUCTATUS | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 400 | 74 | 2065 | IDAHO | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORDS IDAHO RECYCLIN |
| 300 | 75 | 2339 | IDAHO | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 300 | 73 | 1851 | IDENTIFICATION | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 700 | 69 | 1863 | IDENTIFICATION | METHODS FOR RAPID IDENTIFICATION AND ENUMERATION OF STREPTOCOCCUS BOVIS FROM WATER KEY |
| 300 | 74 | 2248 | IDENTIFICATION | IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR |
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| 200 | 75 | 2610 | ILLINOIS | AN ILLINOIS FEEDLOT RUNOFF CONTROL PROJECT KEYWORDS ILLINOIS FEEDLOTS DESIGN SPRINKLE |
| 200 | 75 | 2613 | ILLINOIS | UTILIZATION OF BEEF CATTLE WASTE FROM A SLOTTED FLOOR DEEP PIT BARN KEYWORDS CONFINEM |
| 200 | 73 | 2440 | ILLINOIS-UNIVERSIT | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
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| 200 | 74 | 2034 | IMPERVIOUS-MEMBRAN | SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES KEYWORDS DAIRY-INDUSTRY SOIL |
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| 400 | 73 | 1922 | KAOLIN | KAOLIN RESULTS IN DRIER DROPPINGS KEYWORDS POULTRY ADDITIVES EXCRETA KAOLIN FLY-CONTR |
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| 200 | 75 | 2609 | LAND-DISPOSAL | MANAGEMENT OF RUNOFF WATER IN RELATION TO FEEDLOT OPERATIONS KEYWORDS AGRICULTURAL-RUN |
| 200 | 75 | 2611 | LAND-DISPOSAL | FEEDLOT WASTE RECYCLING WITH A FLUSH CLEANING SYSTEM KEYWORDS FEEDLOTS WASTE-STORAGE W |
| 200 | 75 | 2613 | LAND-DISPOSAL | UTILIZATION OF BEEF CATTLE WASTE FROM A SLOTTED FLOOR DEEP PIT BARN KEYWORDS CONFINEM |
| 200 | 75 | 2616 | LAND-DISPOSAL | MILKING CENTER WASTE MANAGEMENT KEYWORDS DAIRY-INDUSTRY RECYCLING IRRIGATION EFFLUENT |
| 200 | 75 | 2619 | LAND-DISPOSAL | A LIQUID MANURE MANAGEMENT SYSTEM IN A TIE STALL DAIRY BARN KEYWORDS LIQUID-WASTES DA |
| 200 | 75 | 2620 | LAND-DISPOSAL | A COMPLETE DAIRY LIQUID MANURE SYSTEM KEYWORDS DAIRY-INDUSTRY LIQUID-WASTES WASTE-STO |
| 200 | 75 | 2622 | LAND-DISPOSAL | SELF UNLOADING PITS IN A DAIRY MANURE MANAGEMENT SYSTEM KEYWORDS WASTE-STORAGE WASTE-D |
| 200 | 75 | 2623 | LAND-DISPOSAL | A PLANNING STUDY ON DAIRY WASTES MANAGEMENT KEYWORDS DAIRY-INDUSTRY CALIFORNIA WATER-P |
| 200 | 75 | 2625 | LAND-DISPOSAL | THE DAKOTA SYSTEM-A METHOD OF COLLECTING STORING AND HANDLING ANIMAL WASTE KEYWORDS D |
| 200 | 75 | 2626 | LAND-DISPOSAL | MANURE PONDS FOR MINIMIZING POLLUTION KEYWORDS WISCONSIN DAIRY-INDUSTRY COSTS DESIGN |
| 200 | 75 | 2632 | LAND-DISPOSAL | MANAGING A SUCCESSFUL LIQUID SWINE MANURE MANAGEMENT SYSTEM KEYWORDS LIQUID-WASTES WA |
| 200 | 75 | 2633 | LAND-DISPOSAL | TOTAL WASTE MANAGEMENT FOR A LARGE SWINE PRODUCTION FACILITY KEYWORDS COSTS SPRINKLER- |
| 200 | 75 | 2636 | LAND-DISPOSAL | A WASTE MANAGEMENT SYSTEM FOR A 2500-HEAD SWINE OPERATION-A CASE STUDY KEYWORDS LIQUI |
| 200 | 75 | 2637 | LAND-DISPOSAL | KSU AEROBIC SWINE WASTE HANDLING SYSTEM-SIX YEARS OF PROBLEMS AND PROGRESS KEYWORDS A |
| 200 | 75 | 2639 | LAND-DISPOSAL | A PIG SLURRY TREATMENT SYSTEM BASED ON SEPARATION BEFORE AEROBIC TREATMENT AND SLUDGE D |
| 200 | 75 | 2660 | LAND-DISPOSAL | RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE ON GRAIN SORGHUM YIELDS KEYWORDS FERTILIZE |
| 200 | 75 | 2661 | LAND-DISPOSAL | DIRECT LAND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF NUTRIENTS LAND-DI |
| 200 | 75 | 2662 | LAND-DISPOSAL | LAND DISPOSAL OF BEEF WASTES-CLIMATE RATES SALINITY AND SOIL KEYWORDS CATTLE CROP-RESP |
| 200 | 75 | 2663 | LAND-DISPOSAL | DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND KEYWORDS FEEDLOTS CATTLE KANSAS CROP-RESPONS |
| 200 | 75 | 2664 | LAND-DISPOSAL | LONG TERM BROILER LITTER FERTILIZATION OF TALL FESCUE PASTURES AND HEALTH AND PERFORMAN |
| 200 | 75 | 2665 | LAND-DISPOSAL | MANURE FROM CAGED HENS EVALUATED ON FESCUE PASTURE KEYWORDS POULTRY FESCUES CROP-RESPO |
| 200 | 75 | 2667 | LAND-DISPOSAL | THE YIELD RESPONSE OF GRASS TO AEROBICALLY STABILIZED SWINE WASTE KEYWORDS CROP-RESPO |
| 200 | 75 | 2669 | LAND-DISPOSAL | NUTRIENT LOSSES FROM LIVESTOCK WASTE DURING STORAGE TREATMENT AND HANDLING KEYWORDS N |
| 200 | 75 | 2676 | LAND-DISPOSAL | NUTRIENT CHARACTERISTICS OF WASTES FROM DEEP PITS AND ANAEROBIC LAGOONS KEYWORDS LAGO |
| 200 | 75 | 2679 | LAND-DISPOSAL | BACTERIAL ANALYSIS AND LAND DISPOSAL OF FARM WASTE LAGOON WATERS KEYWORDS LAGOONS BAC |
| 200 | 75 | 2685 | LAND-DISPOSAL | EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TO VARIATIONS IN CONCENTRATIONS OF SOD |
| 200 | 75 | 2702 | LAND-DISPOSAL | AN ECONOMIC AND MANAGERIAL EVALUATION OF MANURE FLUMING AND LAND APPLICATION SYSTEMS K |
| 200 | 75 | 2704 | LAND-DISPOSAL | FIELD EVALUATION OF A SETTLING CHAMBER FOR SWINE WASTES KEYWORDS SEPARATION-TECHNIQUES |
| 200 | 75 | 2707 | LAND-DISPOSAL | A COMPUTER SIMULATION OF STORAGE AND LAND DISPOSAL OF SWINE WASTE KEYWORDS WASTE-STOR |
| 200 | 75 | 2714 | LAND-DISPOSAL | PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS KEYWORDS E |
| 200 | 75 | 2715 | LAND-DISPOSAL | EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL KEYWORDS |
| 200 | 75 | 2737 | LAND-DISPOSAL | SLUDGE MANAGEMENT FOR ANAEROBIC DAIRY WASTE LAGOONS KEYWORDS SLUDGE ANAEROBIC-LAGOONS |
| 200 | 75 | 2738 | LAND-DISPOSAL | TRENDS AND VARIATIONS IN AN ANAEROBIC LAGOON WITH RECYCLING KEYWORDS LAGOONS ANAEROBI |
| 200 | 75 | 2742 | LAND-DISPOSAL | AEROBIC TREATMENT OF PIGGERY WASTE PRIOR TO LAND TREATMENT-A CASE STUDY KEYWORDS AERO |
| 200 | 75 | 2745 | LAND-DISPOSAL | SURFACE AERATION-DESIGN AN PERFORMANCE FOR LAGOONS KEYWORDS AERATION DESIGN PERFORMAN |
| 200 | 75 | 2748 | LAND-DISPOSAL | PRESENT KNOWLEDGE ON THE EFFECTS OF LAND APPLICATION OF ANIMAL WASTE KEYWORDS ANIMAL- |
| 200 | 75 | 2751 | LAND-DISPOSAL | DISPOSAL OF DAIRY CATTLE MANURE ON SOIL KEYWORDS DAIRY-INDUSTRY CATTLE SOILS CROP-RES |
| 200 | 75 | 2755 | LAND-DISPOSAL | ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION KEYW |
| 200 | 75 | 2757 | LAND-DISPOSAL | COMPOSITION OF POULTRY MANURE AND EFFECT OF HEAVY APPLICATION ON SOIL CHEMICAL PROPERTI |
| 100 | 72 | 2764 | LAND-DISPOSAL | THE REMOVAL OF ANIMAL EXCREMENTS FROM MASS-STOCK FARMS AS A WATER ECONOMY PROBLEM KEYW |
| 700 | 74 | 2765 | LAND-DISPOSAL | ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE ON THE FEEDLOT SOIL PROFILE |
| 100 | 70 | 2769 | LAND-DISPOSAL | THE DISPOSAL OF INTRACTABLE INDUSTRIAL AND AGRICULTURAL WASTES-CONCLUSION KEYWORDS AG |
| 700 | 73 | 2772 | LAND-DISPOSAL | ECONOMICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS COMPLYING WITH POLLUTION-CONTROL-REGU |
| 700 | 70 | 2781 | LAND-DISPOSAL | AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS KEYWOR |
| 100 | 71 | 2782 | LAND-DISPOSAL | LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS KEYWORDS COMPUTER-MODELS WASTE- |
| 700 | 73 | 2792 | LAND-DISPOSAL | THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE KE |
| 400 | 72 | 2795 | LAND-DISPOSAL | FINALLY A CREATIVE PROFITABLE SOLUTION TO AGE OLD WASTE PROBLEM KEYWORDS CATTLE MUNIC |
| 100 | 73 | 2798 | LAND-DISPOSAL | EFFECT OF NITROGEN AND FARM YARD MANURE ON FINGER MILLET ELEUSINE CORACANA L GAERTN KE |
| 100 | 71 | 2806 | LAND-DISPOSAL | AN ECOLOGICAL BLUEPRINT FOR TODAY KEYWORDS WASTE-DISPOSAL SAMPLING CHEMICAL-PROPERTIE |
| 400 | 71 | 2810 | LAND-DISPOSAL | LIVESTOCK WASTE-WHY WASTE IT KEYWORDS WASTE-DISPOSAL LIVESTOCK ECONOMICS LAGOONS DEHY |
| 100 | 72 | 2811 | LAND-DISPOSAL | THE USE OF ANIMAL WASTES ON FERTILIZER KEYWORDS FERTILIZERS IRRIGATION ANIMAL-WASTES |
| 600 | 75 | 2546 | LAND-DISPOSAL-TECH | NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT KEYWORDS TECHNOLOGY NUTRIENTS NITROG |
| 400 | 70 | 2803 | LAND-MANAGEMENT | FEEDLOT POLLUTION-A SOLVABLE PROBLEM KEYWORDS AGRICULTURAL-RUNOFF WATER-POLLUTION SOU |
| 200 | 71 | 1646 | LAND-SPREADING | SYSTEMS AND SITUATIONS FOR HANDLING POULTRY WASTES KEYWORDS POULTRY WASTE-HANDLING RE |
| 100 | 73 | 1653 | LAND-SPREADING | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 300 | 71 | 1672 | LAND-SPREADING | EFFECT OF APPLYING SWINE FECES ON SOIL AND PLANT MINERAL LEVELS KEYWORDS SWINE FECES |
| 600 | 71 | 1724 | LAND-SPREADING | WASTE APPLICATION TO SOILS KEYWORDS FARM-WASTES APPLICATION-METHODS SOILS FERTILIZERS |
| 300 | 72 | 1802 | LAND-SPREADING | ENVIRONMENTAL ECONOMIC AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE M |
| 200 | 70 | 1805 | LAND-SPREADING | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 100 | 73 | 1806 | LAND-SPREADING | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 400 | 72 | 1807 | LAND-SPREADING | CONFINEMENT PAYS IF WEATHER IS BAD KEYWORDS CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL |
| 400 | 74 | 1810 | LAND-SPREADING | NO CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 600 | 74 | 1847 | LAND-SPREADING | CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION KEYWORDS LIQU |
| 300 | 72 | 1878 | LAND-SPREADING | MAINE GUIDELINES FOR MANURE SLUDGE DISPOSAL ON LAND KEYWORDS MANURE SLUDGE MAINE LAND |
| 300 | 71 | 1879 | LAND-SPREADING | THE STOCKMANS ROLE IN WATER POLLUTION CONTROL KEYWORDS WATER-POLLUTION-CONTROL LEGAL-A |
| 400 | 68 | 1884 | LAND-SPREADING | THE COWS VS THE SUBURBS KEYWORDS DAIRY-INDUSTRY COSTS RESEARCH-AND-DEVELOPMENT WATER- |
| 200 | 74 | 2000 | LAND-SPREADING | IMPLICATIONS OF EFFLUENT GUIDELINES AND OTHER POLLUTION CONTROL MEASURES ON DAIRY FARMS |
| 200 | 74 | 2009 | LAND-SPREADING | EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATIO |
| 200 | 74 | 2011 | LAND-SPREADING | LAND DISPOSAL PARAMETERS FOR DAIRY MANURE KEYWORDS DAIRY-INDUSTRY NUTRIENTS SEDIMENT- |
| 400 | 71 | 2083 | LAND-SPREADING | DO MANURE STACKS ADD TO FLY CONTROL PROBLEMS KEYWORDS BREEDING DAIRY-INDUSTRY FLY-CONT |
| 300 | | 2085 | LAND-SPREADING | DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL- |
| 200 | 63 | 2161 | LAND-SPREADING | AGRICULTURAL VALUE OF POULTRY MANURE KEYWORDS POULTRY ORGANIC-MATTER COSTS FERTILIZER |
| 700 | 69 | 2181 | LAND-SPREADING | AEROBIC STORAGE OF DAIRY CATTLE MANURE KEYWORDS WASTE-STORAGE AEROBIC-CONDITIONS DAIR |
| 400 | 72 | 2231 | LAND-SPREADING | MANURE CAN CUT YOUR FERTILIZER BILL KEYWORDS FERTILIZERS COSTS NUTRIENTS NITROGEN PH |
| 100 | 72 | 2359 | LAND-SPREADING | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR |
| 100 | 74 | 2430 | LAND-SPREADING | ODOR REDUCTION FOR LIQUID MANURE SYSTEMS KEYWORDS ODOR MEASUREMENT LIQUID-WASTES INJE |
| 200 | 73 | 2472 | LAND-SPREADING | MIDWEST LIVESTOCK WASTE MANAGEMENT CONFERENCE KEYWORDS FEEDLOTS HYDROLOGY DESIGN CONFI |
| 200 | 75 | 2590 | LAND-SPREADING | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 200 | 75 | 2598 | LAND-SPREADING | ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS I |
| 200 | 75 | 2610 | LAND-SPREADING | AN ILLINOIS FEEDLOT RUNOFF CONTROL PROJECT KEYWORDS ILLINOIS FEEDLOTS DESIGN SPRINKLE |
| 200 | 75 | 2668 | LAND-SPREADING | A PRACTICAL MANAGEMENT SYSTEM FOR POLLUTION-FREE LAND SPREADING OF ANIMAL WASTES KEYWO |
| 200 | 75 | 2672 | LAND-SPREADING | NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS KEYWORDS WINTER AGRICUL |
| 200 | 75 | 2674 | LAND-SPREADING | EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED |
| 200 | 75 | 2700 | LAND-SPREADING | IF YOU CANNOT SPREAD IT TREAT IT KEYWORDS SLURRIES WASTE-TREATMENT SEPARATION-TECHNIQ |

# KEYWORD INDEX

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|---|---|---|---|---|
| 700 | 71 | 2771 | LAND-SPREADING | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 100 | 74 | 2784 | LAND-SPREADING | REGIONAL MANAGEMENT OF ANIMAL MANURES-A MODEL FOR COLLECTION STORAGE LOCATION AND DISTR |
| 300 | 68 | 2220 | LAND-USE | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 300 | 72 | 1647 | LARVAE | HOUSE FLY CONTROL IN CAGED LAYER HOUSES KEYWORDS LARVAE FLY-CONTROL CAGED-LAYERS-HOUS |
| 100 | 61 | 1670 | LARVAE | TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE FED CATTLE KEYWORD |
| 100 | 65 | 1750 | LARVAE | COMPARATIVE EFFECTIVENESS AND PERSISTENCE OF CERTAIN INSECTICIDES IN POULTRY DROPPINGS |
| 600 | 72 | 1752 | LARVAE | ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE KEYWORDS AERATION LARVAE F |
| 100 | 73 | 1801 | LARVAE | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE K |
| 100 | 70 | 1823 | LARVAE | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE KEYWORDS FEEDS ADD |
| 400 | 74 | 1827 | LARVAE | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AER |
| 100 | 67 | 2264 | LARVAE | LARVICIDAL ACTIVITY TO FLIES OF MANURE FROM CHICKS ADMINISTERED INSECTICIDE TREATED FEE |
| 100 | 60 | 1677 | LARVAL-CONTROL | FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES KEYWORDS FEED-ADDIT |
| 100 | 74 | 2189 | LARVAL-GROWTH-STAG | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 100 | 70 | 2520 | LARVAL-MORTALITY | POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANU |
| 100 | 70 | 1823 | LARVICIDES | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE KEYWORDS FEEDS ADD |
| 100 | 73 | 2325 | LARVICIDES | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 200 | 73 | 2439 | LARVICIDES | MOSQUITO CONTROL IN LIVESTOCK WASTE LAGOONS IN ILLINOIS 1972 KEYWORDS LAGOONS MOSQUIT |
| 100 | 74 | 1894 | LATENT-HEAT | HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS KEYWORDS DES |
| 700 | 73 | 2583 | LATENT-HEAT | CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK |
| 200 | 69 | 2488 | LAWSUITS | PERSONAL SIDELIGHTS AND OBSERVATIONS OF THE HBI TRIAL KEYWORDS ODOR LAGOONS ZONING LAW |
| 400 | 74 | 1799 | LAWS | FARM POLLUTION-HOW REGULATIONS AFFECT YOU KEYWORDS PERMITS REGULATION LIVESTOCK FARM-W |
| 400 | 72 | 1836 | LAYERS | FEEDING POULTRY MANURE TO ANIMALS KEYWORDS FEEDS EXCRETA DEHYDRATED-POULTRY-WASTE SHE |
| 400 | 67 | 2420 | LAYERS | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 400 | 72 | 2299 | LAYER-HENS | DPW RECYCLING FACTS UPDATED KEYWORDS RECYCLING COSTS PERFORMANCES LAYER-HENS DEHYDRAT |
| 400 | 74 | 1772 | LAYING-HENS | DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS POULTRY FEEDS DIET |
| 400 | 73 | 2266 | LAYING-HENS | VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY KEYWORDS FEEDS POULTRY ENERGY |
| 100 | 75 | 2427 | LAYING-HENS | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 200 | 74 | 2152 | LAYING-HOUSE | HANDLING DEHYDRATION AND UTILIZATION OF POULTRY WASTE KEYWORDS DEHYDRATION POULTRY REC |
| 600 | 72 | 1875 | LC50 | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 700 | 72 | 2578 | LEACHATES | NITROGEN TRANSFORMATION AND MOVEMENT IN A MARINE SEDIMENT SOIL FOLLOWING TREATMENT WITH |
| 700 | 73 | 2584 | LEACHATE-ANALYSIS | MINIMAL TREATMENT OF SWINE MANURE FOR IRRIGATION EFFECT ON NITROGEN KEYWORDS AEROBIC |
| 700 | 71 | 1762 | LEACHING | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |
| 600 | 74 | 1845 | LEACHING | ANIMAL WASTE AND NITRATE MOVEMENT THROUGH SOIL KEYWORDS ANIMAL-WASTES GROUNDWATER-POLL |
| 200 | 73 | 1895 | LEACHING | AGRICULTURAL WASTES AND GROUND WATER QUALITY KEYWORDS WATER-POLLUTION-SOURCES FARM-WAS |
| 300 | 66 | 1897 | LEACHING | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION KEYWORDS POULTRY CHE |
| 200 | 74 | 2009 | LEACHING | EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATIO |
| 100 | 74 | 2082 | LEACHING | WASTE ACCUMULATION ON A SELECTED DAIRY CORRAL AND ITS EFFECT ON THE NITRATE AND SALT OF |
| 100 | 74 | 2131 | LEACHING | THE EFFECT OF LARGE APPLICATIONS OF MANURE ON MOVEMENT OF NITRATE AND CARBON IN AN IRRI |
| 200 | 64 | 2182 | LEACHING | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N |
| 700 | 74 | 2362 | LEACHING | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 300 | 75 | 2507 | LEACHING | MANAGE MANURE FOR ITS VALUE KEYWORDS SOLID-WASTES LIQUID-WASTES CROP-RESPONSE ODOR |
| 200 | 75 | 2750 | LEACHING | ON-THE-FARM DETERMINATION OF ANIMAL WASTE DISPOSAL RATES FOR CROP PRODUCTION KEYWORDS |
| 100 | 70 | 2794 | LEACHING | SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT KEYWORDS POULTRY PORTLAND-CEMENTS FLY-A |
| 300 | | 1767 | LEAKAGE | MANURE WASTE PONDING STUDY KEYWORDS GROUNDWATER-POLLUTION NITRATES HOLDING-PONDS MANU |
| 100 | 72 | 1681 | LEGAL-ASPECTS | ANIMAL WASTE MANAGEMENT PROBLEMS AND GUIDELINES FOR SOLUTIONS KEYWORDS WASTE-MANAGEME |
| 200 | 64 | 1691 | LEGAL-ASPECTS | SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS POULTRY EXCRE |
| 200 | 64 | 1697 | LEGAL-ASPECTS | SOCIAL AND LEGAL IMPLICATIONS OF ORGANIC WASTE MANAGEMENT KEYWORDS ORGANIC-WASTES MANA |
| 200 | 64 | 1704 | LEGAL-ASPECTS | SOCIAL LEGAL AND ECONOMIC CONSIDERATIONS OF ANIMAL PRODUCTION IN URBANIZED AREAS KEYWO |
| 600 | 71 | 1713 | LEGAL-ASPECTS | ANIMAL WASTE MANAGEMENT CONFERENCE KEYWORDS WASTE-MANAGEMENT LIVESTOCK CONFINEMENT-PEN |
| 600 | 71 | 1714 | LEGAL-ASPECTS | ANIMAL WASTE MANAGEMENT-COMMENTS ON THE NATIONAL SITUATION KEYWORDS WASTE-MANAGEMENT |
| 600 | 71 | 1728 | LEGAL-ASPECTS | LEGAL ASPECTS OF LIVESTOCK PRODUCTION AND WASTE MANAGEMENT KEYWORDS LEGAL-ASPECTS LIV |
| 300 | 73 | 1733 | LEGAL-ASPECTS | THE ECONOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA KEYWORDS FEEDLOTS CATTLE ZONIN |
| 400 | 74 | 1770 | LEGAL-ASPECTS | COSTS NOTED FOR SOLID AND LIQUID WASTE SYSTEM KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LI |
| 300 | 72 | 1775 | LEGAL-ASPECTS | ECONOMIC IMPLICATIONS OF WATER POLLUTION ABATEMENT IN FAMILY FARM LIVESTOCK PRODUCTION |
| 300 | 68 | 1776 | LEGAL-ASPECTS | POLLUTION IMPLICATIONS OF ANIMAL WASTES-A FORWARD ORIENTED REVIEW KEYWORDS CATTLE HO |
| 300 | 70 | 1814 | LEGAL-ASPECTS | FEEDLOT POLLUTION KEYWORDS FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION |
| 300 | 72 | 1830 | LEGAL-ASPECTS | LIQUID MANURE MANAGEMENT FOR SWINE KEYWORDS LIQUID-WASTES SWINE WASTE-MANAGEMENT MANU |
| 100 | 73 | 1833 | LEGAL-ASPECTS | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 300 | 73 | 1851 | LEGAL-ASPECTS | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 200 | 74 | 1869 | LEGAL-ASPECTS | RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM KEYWORDS RECYCLING DRIED-P |
| 300 | 71 | 1879 | LEGAL-ASPECTS | THE STOCKMANS ROLE IN WATER POLLUTION CONTROL KEYWORDS WATER-POLLUTION-CONTROL LEGAL-A |
| 200 | 74 | 1996 | LEGAL-ASPECTS | PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE KEYWORDS REGULATION LEGAL-ASPECTS WAST |
| 200 | 74 | 1998 | LEGAL-ASPECTS | EFFLUENT REGULATIONS FOR LIVESTOCK AND POULTRY FEEDLOTS KEYWORDS ECONOMICS LEGAL-ASPEC |
| 200 | 74 | 1999 | LEGAL-ASPECTS | THE ECONOMIC IMPACTS OF IMPOSING EPA EFFLUENT GUIDELINES ON THE U S FED BEEF INDUSTRY |
| 200 | 74 | 2000 | LEGAL-ASPECTS | IMPLICATIONS OF EFFLUENT GUIDELINES AND OTHER POLLUTION CONTROL MEASURES ON DAIRY FARMS |
| 400 | 65 | 2037 | LEGAL-ASPECTS | MANURE ODORS CAN LAND YOU IN COURT KEYWORDS ODOR LEGAL-ASPECTS URBAN-DEVELOPMENT ZONI |
| 100 | 74 | 2057 | LEGAL-ASPECTS | ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT USE MANURE KEYWORDS |
| 100 | 64 | 2079 | LEGAL-ASPECTS | ODOR CONTROL IN CATTLE FEED YARDS KEYWORDS ODOR MECHANICAL-CONTROL LEGAL-ASPECTS SPRA |
| 100 | 69 | 2084 | LEGAL-ASPECTS | WATER AND WATERCOURSES-WATER POLLUTION LAWS AND THEIR ENFORCEMENT IN OKLAHOMA KEYWORDS |
| 300 | 72 | 2087 | LEGAL-ASPECTS | DUST AND ODOR PROBLEMS OF THE FEEDLOT KEYWORDS ODOR DUST FEEDLOTS AIR-POLLUTION LEGA |
| 500 | 74 | 2132 | LEGAL-ASPECTS | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES KEYWORDS WASTE-TREATM |
| 200 | 74 | 2135 | LEGAL-ASPECTS | AGRICULTURAL WASTE CONFERENCE KEYWORDS ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC |
| 100 | 87 | 2192 | LEGAL-ASPECTS | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 300 | 71 | 2196 | LEGAL-ASPECTS | FEEDLOT WASTE MANAGEMENT-WHY AND HOW KEYWORDS FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON |
| 400 | 74 | 2203 | LEGAL-ASPECTS | NUISANCE LAWSUITS-NEIGHBOR VS NEIGHBOR KEYWORDS LEGAL-ASPECTS WASTE-TREATMENT WASTE-D |
| 300 | 75 | 2335 | LEGAL-ASPECTS | ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES KEYWORDS LEGAL-ASPECTS REGULATION DAIR |
| 400 | 72 | 2376 | LEGAL-ASPECTS | HOW TO DISPOSE OF MANURE AND STAY OUT OF COURT KEYWORDS WASTE-MANAGEMENT LEGAL-ASPECTS |
| 300 | 73 | 2407 | LEGAL-ASPECTS | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS EFFLUE |
| 300 | 71 | 2421 | LEGAL-ASPECTS | WHOSE RESPONSIBILITY-CONTROL OF LIVESTOCK AND POULTRY WASTES KEYWORDS WASTE-DISPOSAL |
| 200 | 73 | 2432 | LEGAL-ASPECTS | LIVESTOCK WASTE MANAGEMENT CONFERENCE KEYWORDS LIVESTOCK ILLINOIS LEGAL-ASPECTS FEED |
| 200 | 73 | 2433 | LEGAL-ASPECTS | STATUS OF THE ILLINOIS LIVESTOCK WASTE MANAGEMENT REGULATIONS KEYWORDS ILLINOIS LEGAL |
| 200 | 74 | 2460 | LEGAL-ASPECTS | MARKETING CONVERTED MANURE KEYWORDS MARKETING FERTILIZERS FEEDS COSTS CALIFORNIA IOWA |
| 200 | 74 | 2463 | LEGAL-ASPECTS | BEEF IN CONFINEMENT WORKSHOP KEYWORDS FEEDLOTS CONFINEMENT-PENS CATTLE LEGAL-ASPECTS |
| 200 | 74 | 2467 | LEGAL-ASPECTS | LEGAL ASPECTS OF WASTE POLLUTION LAWS KEYWORDS LEGAL-ASPECTS FEEDLOTS WATER-POLLUTION |
| 300 | 73 | 2516 | LEGAL-ASPECTS | IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS KEYWORDS MICHIGAN DAIRY-INDUSTRY LEGAL |
| 300 | | 2571 | LEGAL-ASPECTS | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 400 | 72 | 2573 | LEGAL-ASPECTS | A LIVESTOCKMANS GUIDE TO POLLUTION LAWS KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT |
| 200 | 75 | 2599 | LEGAL-ASPECTS | IMPLICATIONS OF SELECTED NON-POINT SOURCE POLLUTION REGULATIONS FOR US DAIRY FARMS KEY |
| 200 | 75 | 2668 | LEGAL-ASPECTS | A PRACTICAL MANAGEMENT SYSTEM FOR POLLUTION-FREE LAND SPREADING OF ANIMAL WASTES KEYWO |
| 700 | 71 | 2771 | LEGAL-ASPECTS | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 700 | 73 | 2772 | LEGAL-ASPECTS | ECONOMICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS COMPLYING WITH POLLUTION-CONTROL-REGU |
| 400 | 64 | 2793 | LEGAL-ASPECTS | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 300 | | 1774 | LEGHORN-MALES | EFFECT OF ATMOSPHERIC AMMONIA AND THE STRESS OF INFECTIOUS BRONCHITIS VACCINATION ON L |
| 400 | 75 | 2116 | LEGISLATION | FEED PRICES ENVIRONMENTAL LAWS HELP SALES OUTLOOK FOR DRYING EQUIPMENT DPW KEYWORDS E |
| 200 | 74 | 2147 | LEGISLATION | PENDING LEGISLATION RELATED TO AGRICULTURAL WASTE KEYWORDS MICHIGAN LEGISLATION WASTE-W |
| 100 | 74 | 2288 | LEGISLATION | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 400 | 75 | 2425 | LEGISLATION | UTILIZING WASTES IN ANIMAL FEEDS-A EUROPEAN OVERVIEW KEYWORDS RECYCLING ORGANIC-WASTE |
| 700 | 73 | 2563 | LEGISLATION | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO A FORAGE SORGHUM KEYWORDS AGRICULTUR |
| 200 | 75 | 2595 | LEGISLATION | ECONOMIC IMPACTS OF ALTERNATIVE WATER POLLUTION CONTROL RULES ON BEEF FEEDLOTS OF LESS |
| 200 | 75 | 2600 | LEGISLATION | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |

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| 200 75 2601 | LEGISLATION | LEGAL ASPECTS OF ODOR POLLUTION CONTROL KEYWORDS AIR-POLLUTION LEGISLATION FEEDLOTS L |
| 200 75 2602 | LEGISLATION | PARTNERSHIP IN POLLUTION CONTROL KEYWORDS WATER-POLLUTION LEGISLATION FEEDLOTS ILLINO |
| 700 71 2771 | LEGISLATION | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 300 73 2384 | LEPTOSPIRA-POMONA | SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS |
| 400 72 2554 | LEPTOSPIROSIS | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 600 72 1875 | LETHAL-LIMIT | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 400 74 1885 | LICENSE | CALIFORNIA ISSUES DPW REGULATIONS KEYWORDS REGULATION DRIED-ANIMAL-WASTES LICENSE PRO |
| 400 65 2037 | LICENSING | MANURE ODORS CAN LAND YOU IN COURT KEYWORDS ODOR LEGAL-ASPECTS URBAN-DEVELOPMENT ZONI |
| 200 74 2146 | LICENSING | LICENSING CONCERNS FOR THE TRANSPORTATION OF ANIMAL WASTES KEYWORDS ANIMAL-WASTES TRA |
| 400 72 1842 | LICOM-WASTE-TREATP | WLJ PREVIEWS FIRST COMMERCIAL MANURE SYSTEM KEYWORDS AEROBIC-TREATMENT LICOM-WASTE-TRE |
| 100 73 1637 | LIMESTONE | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 300 69 2099 | LIME | AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHAN |
| 600 66 2194 | LIME | TREATMENT OF LIQUID HOG MANURE TO SUPPRESS ODORS KEYWORDS WASTE-TREATMENT LIQUID-WAST |
| 100 61 2505 | LIME | THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI |
| 100 74 2525 | LIME | PHOSPHATE REMOVAL FROM DUCK FARM WASTES KEYWORDS WASTE-WATER-POLLUTION WASTE-WATER-TR |
| 100 61 2534 | LIME | WHAT IS POULTRY MANURE WORTH KEYWORDS POULTRY FERTILIZERS WASTE-TREATMENT RECYCLING L |
| 700 73 2792 | LIME | THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE KE |
| 300 74 2042 | LINEAR-MODELS | THE IMPACT ON DAIRY FARM ORGANIZATION OF ALTERNATIVE MANURE DISPOSAL SYSTEMS A METHOD O |
| 300 72 2371 | LINSEED-MEAL | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PHOS |
| 300 73 1907 | LIQUEFACTION | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 300 72 2313 | LIQUEFACTION | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 100 65 2450 | LIQUEFACTION | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION DESIGN HOGS TEMPERATUR |
| 100 74 2075 | LIQUEFICATION | FUEL FROM LIVESTOCK WASTES-AN ECONOMIC ANALYSIS KEYWORDS FUELS ORGANIC-WASTES ECONOMIC |
| 100 72 2580 | LIQUIDS-SOLIDS-SEP | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE |
| 100 73 1773 | LIQUID | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS KEYWORDS DAIRY-INDUSTR |
| 200 74 2016 | LIQUID-AERATION | THE HANDLING AND TREATMENT OF MINK WASTES BY LIQUID AERATION KEYWORDS MINK DESIGN ECO |
| 300 74 1758 | LIQUID-AERATION-SY | DESIGN PARAMETERS FOR ANIMAL WASTE TREATMENT SYSTEMS KEYWORDS LIQUID-AERATION-SYSTEMS |
| 600 68 1862 | LIQUID-CIRCULATION | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 200 75 2720 | LIQUID-CYCLONE | EVALUATION OF SOLIDS SEPARATION DEVICES KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN |
| 200 75 2691 | LIQUID-DILUTION | EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS KEYWORDS FEED |
| 600 74 1687 | LIQUID-MANURE | ABOVE GROUND STORAGE OF LIQUID MANURE KEYWORDS WASTE-STORAGE LIQUID-MANURE DESIGN DAI |
| 100 74 2333 | LIQUID-MANURE | PHENOLIC ACIDS AS INDICATORS OF POLLUTION WITH LIQUID MANURE-A METHOD FOR THEIR DETECTI |
| 100 73 2012 | LIQUID-POULTRY-MAN | PHOSPHORUS IN PERCOLATES FROM MANURED LYSIMETERS KEYWORDS PHOSPHORUS PERCOLATION LYSI |
| 100 73 1773 | LIQUID-SOLID-SEPAR | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS KEYWORDS DAIRY-INDUSTR |
| 600 73 1852 | LIQUID-SOLID-SEPAR | VACUUM FILTRATION OF CATTLE MANURE KEYWORDS VACUUM-FILTRATION SLURRIES SLUDGE MOISTUR |
| 700 72 2316 | LIQUID-SOLID-SEPAR | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 200 75 2719 | LIQUID-SOLID-SEPAR | A ROTATING CONICAL SCREEN SEPARATOR FOR LIQUID-SOLID SEPARATION OF BEEF WASTE KEYWORDS |
| 700 66 1679 | LIQUID-WASTES | TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS WAST |
| 100 72 1681 | LIQUID-WASTES | ANIMAL WASTE MANAGEMENT PROBLEMS AND GUIDELINES FOR SOLUTIONS KEYWORDS WASTE-MANAGEME |
| 200 64 1700 | LIQUID-WASTES | HYDRAULIC MANURE SYSTEMS KEYWORDS HYDRAULICS WASTE-HANDLING ODOR DESIGN CLEANING LIQU |
| 200 64 1701 | LIQUID-WASTES | LIQUID HANDLING PROCESSES FOR POULTRY MANURE UTILIZATION KEYWORDS LIQUID-WASTES WASTE- |
| 700 66 1707 | LIQUID-WASTES | AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS KEYWO |
| 600 71 1718 | LIQUID-WASTES | SYSTEM COMPONENTS TO SEPARATE SOLIDS AND LIQUIDS KEYWORDS SOLID-WASTES LIQUID-WASTES |
| 600 71 1722 | LIQUID-WASTES | WASTE MANAGEMENT SYSTEMS FOR ROOFED BEEF CONFINEMENT FACILITIES KEYWORDS WASTE-MANAGE |
| 600 74 1738 | LIQUID-WASTES | STORAGE LAGOON VERSUS UNDERFLOOR TANK FOR DAIRY CATTLE MANURE KEYWORDS WASTE-SOTRAGE |
| 400 74 1770 | LIQUID-WASTES | COSTS NOTED FOR SOLID AND LIQUID WASTE SYSTEM KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LI |
| 200 74 1777 | LIQUID-WASTES | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 300 74 1794 | LIQUID-WASTES | LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS KEYWORDS LIQUID-WASTES MANAGEMENT SWINE |
| 300 72 1802 | LIQUID-WASTES | ENVIRONMENTAL ECONOMIC AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE M |
| 300 72 1830 | LIQUID-WASTES | LIQUID MANURE MANAGEMENT FOR SWINE KEYWORDS LIQUID-WASTES SWINE WASTE-MANAGEMENT MANU |
| 300 70 1839 | LIQUID-WASTES | ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL SYSTEMS FOR DAIRY CATTLE KEYWORDS LIQUI |
| 600 74 1847 | LIQUID-WASTES | CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION KEYWORDS LIQU |
| 600 68 1862 | LIQUID-WASTES | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 300 71 1866 | LIQUID-WASTES | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 400 71 1918 | LIQUID-WASTES | NEW PUMP NEW SYSTEM FOR LIQUID MANURE KEYWORDS LIQUID-WASTES COSTS DESIGN WASTE-STORA |
| 200 71 1926 | LIQUID-WASTES | FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS KEYWORDS LIQUID-W |
| 200 71 1933 | LIQUID-WASTES | GUIDELINES FOR HANDLING LIQUID WASTE FROM FEEDLOTS KEYWORDS FEEDLOTS LIQUID-WASTES AG |
| 600 74 1952 | LIQUID-WASTES | EFFECT OF SPRINKLING ON LIQUID ANIMAL WASTE PROPERTIES KEYWORDS SPRINKLING LIQUID-WAST |
| 200 71 1975 | LIQUID-WASTES | LIQUID MANURE HANDLING KEYWORDS LIQUID-WASTES WASTE-STORAGE LAGOONS WASTE-HANDLING HO |
| 200 74 2013 | LIQUID-WASTES | ENERGY AND MONETARY COSTS FOR TWO BEEF CATTLE WASTE DISPOSAL SYSTEMS KEYWORDS ENERGY |
| 200 74 2024 | LIQUID-WASTES | TREATMENT OF BEEF WASTE BY A ROTATING BIOLOGICAL CONTACTOR KEYWORDS AEROBIC-TREATMENT |
| 200 74 2032 | LIQUID-WASTES | EFFECT OF LIQUID SWINE WASTE APPLICATION ON SOIL CHEMICAL COMPOSITION KEYWORDS LIQUID |
| 200 74 2034 | LIQUID-WASTES | SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES KEYWORDS DAIRY-INDUSTRY SOIL |
| 300 74 2044 | LIQUID-WASTES | LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS KEYWORDS LIQ |
| 400 75 2055 | LIQUID-WASTES | THEY PLAN TO EXPORT LIQUID MANURE TO THE ARABS KEYWORDS LIQUID-WASTES EXPORT FERTILIZE |
| 400 75 2056 | LIQUID-WASTES | MILK PLUS MANURE-HIGHER DAIRY PROFITS KEYWORDS SEPARATION-TECHNIQUES DAIRY-INDUSTRY L |
| 400 74 2065 | LIQUID-WASTES | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORDS IDAHO RECYCLIN |
| 400 74 2066 | LIQUID-WASTES | HOW IRRIGATION CAN BE USED TO HANDLE MANURE KEYWORDS IRRIGATION WASTE-DISPOSAL COSTS D |
| 600 74 2081 | LIQUID-WASTES | TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES KEYWORDS SOIL-PROFILE |
| 300 2085 | LIQUID-WASTES | DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL- |
| 300 72 2088 | LIQUID-WASTES | ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS KEYWORDS LIQUID-WAST |
| 100 73 2113 | LIQUID-WASTES | EFFECTS OF APPLICATION RATE IN DIRECT LAND DISPOSAL OF ANIMAL WASTES KEYWORDS EFFECTS |
| 400 74 2114 | LIQUID-WASTES | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 300 74 2118 | LIQUID-WASTES | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 200 63 2159 | LIQUID-WASTES | PROGRESS REPORT ON MANURE HARVESTING KEYWORDS POULTRY LIQUID-WASTES WASTE-STORAGE WAS |
| 600 66 2194 | LIQUID-WASTES | TREATMENT OF LIQUID HOG MANURE TO SUPPRESS ODORS KEYWORDS WASTE-TREATMENT LIQUID-WAST |
| 100 71 2200 | LIQUID-WASTES | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 64 2204 | LIQUID-WASTES | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 700 73 2212 | LIQUID-WASTES | HYDROLOGY OF ANIMAL WASTE WATER PONDS KEYWORDS WASTE-WATER-POLLUTION PONDS HYDROLOGY |
| 300 74 2215 | LIQUID-WASTES | A COMPARISON OF SOLID AND LIQUID MANURE STORAGE SYSTEMS KEYWORDS WASTE-STORAGE SOLID-W |
| 100 74 2223 | LIQUID-WASTES | COMPARISON OF THE CONVENTIONAL CAGE ROTOR AND JET-AERO-MIX SYSTEMS IN OXIDATION DITCH |
| 400 72 2224 | LIQUID-WASTES | DAIRY WASTE GOES FULL CYCLE IN RESEARCH KEYWORDS DAIRY-INDUSTRY LAND-DISPOSAL LIQUID- |
| 700 69 2225 | LIQUID-WASTES | AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON THE AGITATION AND REMOVAL O |
| 300 75 2284 | LIQUID-WASTES | PROFITS FROM DAIRY MANURE APPLICATION KEYWORDS DAIRY-INDUSTRY COSTS PROFITS LIQUID-WA |
| 400 72 2290 | LIQUID-WASTES | NEW WASTE TREATMENT SYSTEM IS USED FOR HOGS KEYWORDS WASTE-TREATMENT SEPARATION-TECHNI |
| 400 71 2296 | LIQUID-WASTES | FOREST LAND FOR MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL FOREST-MANAGEMENT NITROGEN LI |
| 700 68 2317 | LIQUID-WASTES | FERTILIZING VALUE OF CATTLE MANURE IN RELATION TO TREATMENT AND METHOD OF HANDLING KEY |
| 400 75 2344 | LIQUID-WASTES | SEPARATING SOLID WASTE FROM LIQUID KEYWORDS SOLID-WASTES LIQUID-WASTES CATTLE RECYCL |
| 100 71 2351 | LIQUID-WASTES | EXPERIMENTAL FACILITIES FOR STUDIES ON BEEF HOUSING AND EQUIPMENT KEYWORDS CONFINEMEN |
| 300 73 2355 | LIQUID-WASTES | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 600 74 2356 | LIQUID-WASTES | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 100 74 2403 | LIQUID-WASTES | TECHNICAL ASPECTS OF LIQUID COMPOSTING KEYWORDS DAIRY-INDUSTRY ODOR BIOLOGICAL-TREATM |
| 100 74 2430 | LIQUID-WASTES | ODOR REDUCTION FOR LIQUID MANURE SYSTEMS KEYWORDS ODOR MEASUREMENT LIQUID-WASTES INJE |
| 200 73 2432 | LIQUID-WASTES | LIVESTOCK WASTE MANAGEMENT CONFERENCE KEYWORDS LIVESTOCK ILLINOIS LEGAL-ASPECTS FEED |
| 200 73 2434 | LIQUID-WASTES | STORAGE STRUCTURES FOR SOLID MANURE KEYWORDS WASTE-STORAGE SOLID-WASTES SEPARATION-TE |
| 200 73 2435 | LIQUID-WASTES | MANURE STORAGE TANKS FOR LIQUIDS KEYWORDS WASTE-STORAGE LIQUID-WASTES DESIGN MANURE-S |
| 200 73 2436 | LIQUID-WASTES | MANURE HANDLING BY HYDRAULIC FLUSHING KEYWORDS DESIGN LIQUID-WASTES RECYCLING CONFINE |
| 200 73 2441 | LIQUID-WASTES | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 200 73 2445 | LIQUID-WASTES | MY WASTE HANDLING SYSTEM FOR DAIRY KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LIQUID-WASTE |
| 200 73 2446 | LIQUID-WASTES | LIVESTOCK WASTE MANAGEMENT IN A QUALITY ENVIRONMENT KEYWORDS FEEDLOTS LIVESTOCK AGRICU |

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| 200 | 74 | 2469 | LIQUIC-WASTES | ANIMAL WASTE HANDLING AND CAN THE TAIL WAG THE DOG KEYWORDS COSTS FEEDLOTS FERTILIZER |
| 300 | 75 | 2507 | LIQUIC-WASTES | MANAGE MANURE FOR ITS VALUE KEYWORDS SOLID-WASTES LIQUID-WASTES CROP-RESPONSE ODOR |
| 300 | 72 | 2533 | LIQUIC-WASTES | DAIRY WASTE STORAGE PONDS FOR SOIL PLANT RECYCLING KEYWORDS DAIRY-INDUSTRY WASTE-STOR |
| 300 | 74 | 2556 | LIQUIC-WASTES | WATER QUALITY AND SOIL EROSION FROM SURFACE APPLICATION OF TREATED LIQUID SWINE WASTE |
| 200 | 75 | 2619 | LIQUID-WASTES | A LIQUID MANURE MANAGEMENT SYSTEM IN A TIE STALL DAIRY BARN KEYWORDS LIQUID-WASTES DA |
| 200 | 75 | 2620 | LIQUIC-WASTES | A COMPLETE DAIRY LIQUID MANURE SYSTEM KEYWORDS DAIRY-INDUSTRY LIQUID-WASTES WASTE-STO |
| 200 | 75 | 2625 | LIQUIC-WASTES | THE DAKOTA SYSTEM-A METHOD OF COLLECTING STORING AND HANDLING ANIMAL WASTE KEYWORDS D |
| 200 | 75 | 2632 | LIQUIC-WASTES | MANAGING A SUCCESSFUL LIQUID SWINE MANURE MANAGEMENT SYSTEM KEYWORDS LIQUID-WASTES WA |
| 200 | 75 | 2636 | LIQUIC-WASTES | A WASTE MANAGEMENT SYSTEM FOR A 2500-HEAD SWINE OPERATION-A CASE STUDY KEYWORDS LIQUI |
| 200 | 75 | 2673 | LIQUID-WASTES | ANIMAL WASTE CONTRIBUTICN TO NITRATE NITROGEN IN SOIL KEYWORDS LIQUID-WASTES DAIRY-IND |
| 200 | 75 | 2684 | LIQUIC-WASTES | SWINE WASTE LAGOONS AS POTENTIAL DISEASE RESERVOIRS KEYWORDS LAGOONS DISEASES PATHOGE |
| 200 | 75 | 2696 | LIQUIC-WASTES | ODOR CONTROL OF LICUID DAIRY AND SWINE MANURE USING CHEMICAL AND BIOLOGICAL TREATMENTS |
| 200 | 75 | 2698 | LIQUIC-WASTES | CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO RECUCE MALODORS KEYWORDS CHEMICAL-TREATME |
| 200 | 75 | 2703 | LIQUID-WASTES | ENERGETICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS KEYWORDS RECYCLING COSTS LIQUID-WAS |
| 200 | 75 | 2704 | LIQUIC-WASTES | FIELD EVALUATION OF A SETTLING CHAMBER FOR SWINE WASTES KEYWORDS SEPARATION-TECHNIQUES |
| 200 | 75 | 2712 | LIQUID-WASTES | PROPERTIES OF SOLIDS AND LIQUIDS FROM STACKED MANURE KEYWORDS SOLID-WASTES LIQUID-WAST |
| 200 | 75 | 2728 | LIQUIC-WASTES | LIQUID COMPOSTING OF DAIRY MANURE KEYWORDS LIQUID-WASTES DAIRY-INDUSTRY CALIFORNIA E |
| 200 | 75 | 2729 | LIQUID-WASTES | LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES KEYWORDS LIQUID-WASTES EQUIPMENT AER |
| 200 | 75 | 2730 | LIQUIC-WASTES | INVESTIGATIONS ON THE PROCEDURE AND THE TURN-OVER CF ORGANIC MATTER BY HOT FERMENTATION |
| 200 | 75 | 2749 | LIQUIC-WASTES | COMPARISON OF LINT COTTON FIELUS FOLLOWING APPLICATIONS OF BEEF CATTLE WASTES AND COMM |
| 200 | 75 | 2755 | LIQUID-WASTES | ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION KEYW |
| 300 | 71 | 2387 | LIQUIFICATION | BIOLOGICAL TREATMENT OF BEEF ANIMAL WASTES KEYWORDS ANAEROBIC-DIGESTION WASTE-TREATMEN |
| 200 | 75 | 2695 | LICUIFICATION | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CCNTROL ODOR AND LIQUEFY ORGANIC WAST |
| 300 | 71 | 1903 | LITERATURE-REVIEW | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 100 | 74 | 2126 | LITERATURE-REVIEW | AGRICULTURAL WASTES KEYWORDS LIVESTOCK PROPERTIES WASTE-TREATMENT REFEEDING LAND-DISP |
| 200 | 75 | 2593 | LITERATURE-REVIEW | ECONOMIC RESEARCH PERTAINING TO PROBLEMS OF LIVESTOCK WASTE MANAGEMENT AND POLLUTION CO |
| 200 | 75 | 2669 | LITERATURE-REVIEW | NUTRIENT LOSSES FROM LIVESTOCK WASTE DURING STORAGE TREATMENT AND HANDLING KEYWORDS N |
| 200 | 75 | 2748 | LITERATURE-REVIEW | PRESENT KNOWLEDGE ON THE EFFECTS OF LAND APPLICATION OF ANIMAL WASTE KEYWORDS ANIMAL- |
| 200 | 75 | 2601 | LITIGATION | LEGAL ASPECTS OF ODOR POLLUTION CONTROL KEYWORDS AIR-POLLUTION LEGISLATION FEEDLOTS L |
| 100 | 61 | 2534 | LITTERS | WHAT IS POULTRY MANURE WORTH KEYWORDS POULTRY FERTILIZERS WASTE-TREATMENT RECYCLING L |
| 400 | 69 | 2540 | LITTERS | APPLY MORE NOT LESS POULTRY LITTER TC REDUCE POLLUTION KEYWORDS AGRICULTURAL-RUNOFF AM |
| 300 | 65 | 2558 | LITTERS | CHICKEN LITTER AS A SUPPLEMENT IN WINTERING BEEF COWS AND CALVES ON PASTURE KEYWORDS |
| 200 | 75 | 2652 | LITTERS | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2664 | LITTERS | LONG TERM BROILER LITTER FERTILIZATION OF TALL FESCUE PASTURES AND HEALTH AND PERFORMAN |
| 400 | 64 | 2793 | LITTERS | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 400 | 73 | 1618 | LITTER | THEY BEAT THE HIGH COST OF PROTEIN WITH PLS KEYWORDS COSTS PROTEINS FEEDS POULTRY LIT |
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| 100 | 75 | 2352 | LUCEDALE-SANDY-LOA | DAIRY CATTLE MANURE-ITS EFFECT ON RYE AND MILLET FORAGE YIELD AND QUALITY  KEYWORDS  DA |
| 200 | 75 | 2651 | LYMPHOID-LEUKOSIS | A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION |
| 600 | 72 | 1893 | LYSIMETERS | LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD |
| 600 | 74 | [illegible]58 | LYSIMETERS | LYSIMETER STUDIES WITH LONG TERM APPLICATION OF SWINE LAGOON EFFLUENT  KEYWORDS  LAGOON |

# KEYWORD INDEX

| | | | | |
|---|---|---|---|---|
| 700 | 70 | 2455 | LYSIMETERS | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE [illegible] |
| 200 | 75 | 2673 | LYSIMETERS | ANIMAL WASTE CONTRIBUTION TO NITRATE NITROGEN IN SOIL KEYWORDS LIQUID-WASTES DAIRY-IND |
| 100 | 73 | 2812 | LYSIMETERS | PHOSPHORUS IN PERCOLATES FROM MANURED LYSIMETERS KEYWORDS PHOSPHORUS PERCOLATION LYSI |
| 100 | 73 | 2431 | LYSINE | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 400 | 72 | 2303 | MAGGOTS | CHICKENS CONTROL FLIES FROM MANURE STACK KEYWORDS POULTRY DAIRY-INDUSTRY FLY-CONTROL |
| 100 | 74 | 2236 | MAGNESIUM | USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL |
| 100 | 73 | 2277 | MAGNESIUM | LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A |
| 300 | 72 | 2371 | MAGNESIUM | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PROS |
| 100 | 75 | 2544 | MAGNESIUM | LAND DISPOSAL OF BROILER LITTER-CHANGES IN SOIL POTASSIUM CALCIUM AND MAGNESIUM KEYWOR |
| 300 | 72 | 1878 | MAINE | MAINE GUIDELINES FOR MANURE SLUDGE DISPOSAL ON LAND KEYWORDS MANURE SLUDGE MAINE LAND |
| 300 | 75 | 2426 | MAINE | USE OF SLUDGE RELIEVES FERTILIZER SHORTAGE KEYWORDS RECYCLING ENERGY FERTILIZERS SLUDG |
| 400 | 64 | 2793 | MAINE | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 200 | 75 | 2614 | MAINTENANCE | EVALUATION OF DAIRY BEEF AND SWINE WASTE HANDLING SYSTEMS KEYWORDS LIVESTOCK DAIRY-IND |
| 200 | 75 | 2637 | MAINTENANCE | KSU AEROBIC SWINE WASTE HANDLING SYSTEM-SIX YEARS OF PROBLEMS AND PROGRESS KEYWORDS A |
| 200 | 75 | 2635 | MAINTENANCE-COSTS | DOUBLE E FARMS-SWINE INSTALLATION KEYWORDS DESIGN LAGOONS COSTS EQUIPMENT MAINTENANCE |
| 100 | 73 | 1790 | MALE-CALVES | A FAECES COLLECTOR SUITABLE FOR MALE CALVES KEYWORDS CATTLE FAECES-COLLECTOR MALE-CAL |
| 300 | 72 | 2087 | MALODORS | DUST AND ODOR PROBLEMS OF THE FEEDLOT KEYWORDS ODOR DUST FEEDLOTS AIR-POLLUTION LAGO |
| 200 | 68 | 2282 | MALODORS | THEORY AND PRACTICE OF ANAEROBIC DIGESTERS AND LAGOONS KEYWORDS ANAEROBIC-DIGESTION LO |
| 100 | 72 | 1621 | MANAGEMENT | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 300 | 72 | 1628 | MANAGEMENT | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 200 | 68 | 1643 | MANAGEMENT | MICROBIOLOGICAL ASPECTS OF POULTRY WASTES KEYWORDS EXCRETA POULTRY MICROBIOLOGY NUTRIE |
| 400 | 73 | 1662 | MANAGEMENT | THESE STOCKYARDS SOLUTIONS COULD WORK FOR YOU KEYWORDS LIVESTOCK FEEDLOTS MANAGEMENT L |
| 200 | 64 | 1697 | MANAGEMENT | SOCIAL AND LEGAL IMPLICATIONS OF ORGANIC WASTE MANAGEMENT KEYWORDS ORGANIC-WASTES MANA |
| 200 | 64 | 1704 | MANAGEMENT | SOCIAL LEGAL AND ECONOMIC CONSIDERATIONS OF ANIMAL PRODUCTION IN URBANIZED AREAS KEYWO |
| 600 | 73 | 1710 | MANAGEMENT | MONITORING ON FARM WASTE MANAGEMENT SYSTEMS KEYWORDS MONITORING FARM-WASTES MANAGEMENT |
| 600 | 71 | 1715 | MANAGEMENT | THE STATE AND REGIONAL SITUATION KEYWORDS FEEDLOTS CONFINEMENT-PENS FARM-WASTES LIVES |
| 300 | 72 | 1775 | MANAGEMENT | ECONOMIC IMPLICATIONS OF WATER POLLUTION ABATEMENT IN FAMILY FARM LIVESTOCK PRODUCTION |
| 400 | 73 | 1778 | MANAGEMENT | MODELS FOR HANDLING SOLID MANURE KEYWORDS SOLID-WASTES MANAGEMENT HANDLING FEEDLOTS [illegible] |
| 300 | 74 | 1794 | MANAGEMENT | LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS KEYWORDS LIQUID-WASTES MANAGEMENT SWINE |
| 300 | 73 | 1851 | MANAGEMENT | ODORS FROM LIVESTOCK PRODUCTION KEYWORDS ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT |
| 300 | 74 | 1860 | MANAGEMENT | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 300 | 74 | 1889 | MANAGEMENT | AGRICULTURAL ANIMALS AND THE ENVIRONMENT KEYWORDS FEEDLOTS MANAGEMENT AIR-POLLUTION [illegible] |
| 200 | 71 | 1970 | MANAGEMENT | FARM ANIMAL WASTE MANAGEMENT-WHAT OUR MILK MARKET REQUIRES KEYWORDS MILK ANIMAL-WASTE |
| 200 | 71 | 1977 | MANAGEMENT | UNIVERSITY OF WISCONSIN RESEARCH ON MANURE HANDLING KEYWORDS WISCONSIN RESEARCH-AND-D |
| 200 | 74 | 1990 | MANAGEMENT | THE DEVELOPMENT OF MANURE HARVESTING PRACTICES FOR BEEF FEEDLOTS KEYWORDS FEEDLOTS MA |
| 400 | 73 | 2067 | MANAGEMENT | DRIED POULTRY MANURE UTILIZATION KEYWORDS RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO |
| 300 | 71 | 2076 | MANAGEMENT | BEEF FEEDLOTS-A POLLUTION PROBLEM KEYWORDS FEEDLOTS MANAGEMENT WATER-POLLUTION AIR-PO |
| 300 | 72 | 2088 | MANAGEMENT | ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS KEYWORDS LIQUID-WAST |
| 300 | 72 | 2105 | MANAGEMENT | LAGOONS FOR ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS DESIGN LOADING LAGO |
| 400 | 72 | 2211 | MANAGEMENT | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING [illegible] |
| 400 | 72 | 221. | MANAGEMENT | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING [illegible] |
| 700 | 73 | 2385 | MANAGEMENT | PHYSICAL PROPERTIES OF A COLD SILTY CLAY LOAM SOIL DURING TWO YEARS IRRIGATION WITH DAI |
| 200 | 75 | 2662 | MANAGEMENT-GUIDELI | LAND DISPOSAL OF BEEF WASTES-CLIMATE RATES SALINITY AND SOIL KEYWORDS CATTLE CROP-RESP |
| 300 | 72 | 2371 | MANGANESE | MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS KEYWORDS FEEDS MINNESOTA ANALYSES PROS |
| 100 | 75 | 2490 | MANGANESE | EFFECTS OF BEEF FEEDLOT MANURE AND LAGOON WATER ON IRON ZINC MANGANESE AND COPPER CONTE |
| 700 | 73 | 2792 | MANGANESE | THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE [illegible] |
| 200 | 73 | 2483 | MANNINGS-EQUATION | DESIGNING GUTTER FLUSHING SYSTEMS KEYWORDS DESIGN-CRITERIA HYDRAULIC-TRANSPORTATION [illegible] |
| 100 | 74 | 2222 | MANURES | COMPARATIVE CHANGES IN SOIL PHYSICAL PROPERTIES INDUCED BY ADMIXTURES OF MANURE FROM [illegible] |
| 300 | 74 | 1619 | MANURE | FERTILIZER VALUE OF DAIRY LOT MANURE KEYWORDS FERTILIZERS DAIRY-INDUSTRY CONFINEMENT- |
| 600 | 73 | 1623 | MANURE | DEWATERING BOVINE ANIMAL MANURE KEYWORDS DEWATERING CATTLE MANURE SLURRIES IRRIGATION |
| 400 | 74 | 1626 | MANURE | MANURE HANDLING SYSTEMS FOR THE FUTURE KEYWORDS MANURE WASTE-HANDLING RECYCLING LAGOO |
| 400 | 74 | 1630 | MANURE | MANURE AS A FUEL KEYWORDS FUELS MANURE WASTE-TREATMENT WASTE-DISPOSAL COMPOSTING AGRI |
| 400 | 74 | 1636 | MANURE | MANURE IS FOOD FOR PROTEIN KEYWORDS MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE |
| 100 | 72 | 1657 | MANURE | MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT SLURRY KEYWORDS NITROGEN FERTIL |
| 600 | 74 | 1684 | MANURE | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 700 | 71 | 1689 | MANURE | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 600 | 73 | 1711 | MANURE | ANAEROBIC DIGESTER RESPONSE WITH DAIRY CATTLE MANURE KEYWORDS ANAEROBIC-DIGESTION DAIR |
| 600 | 71 | 1720 | MANURE | NATURE AND BEHAVIOR OF MANURE KEYWORDS WATER-POLLUTION FEEDLOTS AGRICULTURAL-RUNOFF [illegible] |
| 400 | 72 | 1731 | MANURE | MANURE DEODORANTS-HOW WELL DO THEY WORK KEYWORDS MANURE LIVESTOCK COSTS ODOR-CONTROL |
| 700 | 70 | 1736 | MANURE | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 300 | 73 | 1745 | MANURE | GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS KEYWORDS FEEDLOTS MANURE CATTLE |
| 600 | 73 | 1746 | MANURE | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |
| 200 | 69 | 1760 | MANURE | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 400 | 74 | 1765 | MANURE | MANURE GASES KILL 25 HEAD IN OHIO KEYWORDS MANURE GASES CATTLE OHIO MORTALITY SLOTTED |
| 300 | | 1767 | MANURE | MANURE WASTE PONDING STUDY KEYWORDS GROUNDWATER-POLLUTION NITRATES HOLDING-PONDS MANU |
| 200 | 74 | 1777 | MANURE | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 300 | | 1792 | MANURE | SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF |
| 100 | 73 | 1801 | MANURE | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE [illegible] |
| 100 | 73 | 1806 | MANURE | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 400 | 72 | 1807 | MANURE | CONFINEMENT PAYS IF WEATHER IS BAD KEYWORDS CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL |
| 400 | 74 | 1808 | MANURE | MONFORT FUELS FEEDLOT AND PLANT WITH MANURE KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA |
| 400 | 74 | 1809 | MANURE | MANURE REFEEDING CUTS ODOR SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN KEYWORDS ELECTRIC |
| 400 | 74 | 1810 | MANURE | NO CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 400 | 72 | 1819 | MANURE | GE ENTERS MANURE RECYCLING RACE KEYWORDS MANURE FEEDLOTS RECYCLING FEEDS PROTEINS [illegible] |
| 100 | 70 | 1823 | MANURE | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE KEYWORDS FEEDS ADD |
| 400 | 74 | 1827 | MANURE | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR APP |
| 300 | | 1829 | MANURE | THE TREATMENT OF MANURE IN OXIDATION DITCHES KEYWORDS WASTE-TREATMENT MANURE OXIDATION |
| 300 | 72 | 1830 | MANURE | LIQUID MANURE MANAGEMENT FOR SWINE KEYWORDS LIQUID-WASTES SWINE WASTE-MANAGEMENT MANU |
| 600 | 7[illegible] | 1832 | MANURE | VACUUM FILTRATION OF CATTLE MANURE KEYWORDS VACUUM-FILTRATION SLURRIES SLUDGE MOISTUR |
| 100 | 70 | 1833 | MANURE | INTEGRATED FLY CONTROL PROGRAM FOR CAGED POULTRY HOUSES KEYWORDS FLY-CONTROL CAGED-POU |
| 300 | 72 | 1878 | MANURE | MAINE GUIDELINES FOR MANURE SLUDGE DISPOSAL ON LAND KEYWORDS MANURE SLUDGE MAINE LAND |
| 300 | 71 | 1882 | MANURE | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 600 | 74 | 1888 | MANURE | BEEF FEEDLOT MANURE AND SOIL WATER MOVEMENT KEYWORDS EQUATIONS MANURE WATER-INTAKE-RA |
| 300 | 66 | 1897 | MANURE | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION KEYWORDS POULTRY CHI |
| 600 | 72 | 1901 | MANURE | FACTORS WHICH INFLUENCE THE UTILIZATION OF ANIMAL EXCRETA EITHER DIRECTLY BY ANIMALS OR |
| 100 | 71 | 1902 | MANURE | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 300 | 71 | 1903 | MANURE | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 100 | 71 | 1904 | MANURE | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 300 | 73 | 1907 | MANURE | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-II |
| 400 | 74 | 1909 | MANURE | COOKING WITH COW POWER KEYWORDS METHANE ANAEROBIC-BACTERIA CATTLE FERTILIZERS RECYCLI |
| 400 | 74 | 1923 | MANURE | METHANE PRODUCTION NOT EASY OR PRACTICAL KEYWORDS METHANE MANURE CATTLE RECYCLING COS |
| 400 | 69 | 1924 | MANURE | BIOLOGICAL DIGESTION OF MANURE BY DIPTERA KEYWORDS MANURE DIPTERA BIOLOGICAL-DIGESTIO |
| 100 | 71 | 1936 | MANURE | TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM MEASUREMENT OF DIFFUSIVITY ON CATTLE |
| 400 | 72 | 1942 | MANURE | THAT INESCAPABLE BYPRODUCT KEYWORDS DESIGN FEEDLOTS COLORADO RUNOFF-CONTROL LAND-DISP |
| 400 | 72 | 1944 | MANURE | THE DOOR IS STILL OPEN TO REFEEDING CATTLE WASTE KEYWORDS CATTLE REGULATION PROTEINS |
| 300 | 68 | 1948 | MANURE | THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF MAN |
| 200 | 71 | 1963 | MANURE | SOURCES AND FATE OF AVAILABLE NITROGEN IN RURAL ECOSYSTEMS KEYWORDS NITROGEN NITRATES |
| 200 | 71 | 1967 | MANURE | PHOSPHORUS IN OUR ENVIRONMENT KEYWORDS PHOSPHORUS FERTILIZERS SURFACE-WATERS ENVIRONM |
| 200 | 71 | 1972 | MANURE | PLANNING LAND APPLICATION OF MANURE KEYWORDS PLANNING AGRICULTURAL-RUNOFF SURFACE-WATE |
| 200 | 74 | 1988 | MANURE | MODIFICATION AND ENZYMATIC HYDROLYSIS OF CATTLE FEEDLOT MANURE KEYWORDS FEEDLOTS CATT |

# KEYWORD INDEX

| | | | | |
|---|---|---|---|---|
| 200 | 74 | 1990 | MANURE | THE DEVELOPMENT OF MANURE HARVESTING PRACTICES FOR BEEF FEEDLOTS KEYWORDS FEEDLOTS MA |
| 200 | 74 | 1991 | MANURE | EFFECT OF THE APPLICATION OF BEEF CATTLE FEEDLOT MANURE ON CORN PRODUCTION KEYWORDS |
| 200 | 74 | 2006 | MANURE | CHARACTERIZATION OF WHITE LEGHORN MANURE KEYWORDS FEEDS POULTRY MOISTURE-CONTENT MA |
| 200 | 74 | 2007 | MANURE | THE PRODUCTION RATE AND COMPOSITION OF MANURE FROM GROWING TURKEYS KEYWORDS NUTRIENT |
| 200 | 74 | 2011 | MANURE | LAND DISPOSAL PARAMETERS FOR DAIRY MANURE KEYWORDS DAIRY-INDUSTRY NUTRIENTS SEDIMENT- |
| 200 | 74 | 2018 | MANURE | BEEF FEEDLOT WASTE IN RATIONS FOR BEEF CATTLE KEYWORDS CATTLE DIETS PERFORMANCE REFEED |
| 200 | 74 | 2019 | MANURE | THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE |
| 200 | 74 | 2033 | MANURE | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 400 | 75 | 2049 | MANURE | MANURE ROUGHAGE SILAGE FOR RUMINANTS KEYWORDS SILAGE RUMINANTS NUTRIENTS FEEDS NITROG |
| 100 | 74 | 2057 | MANURE | ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT USE MANURE KEYWORDS |
| 300 | 72 | 2063 | MANURE | COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE KEYWORDS BURNING |
| 400 | 74 | 2093 | MANURE | COMPOSTED CHICKEN LITTER SEEMS TO RECLAIM SALT DAMAGED LAND KEYWORDS SALTS RECLAMATIO |
| 300 | 74 | 2100 | MANURE | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 400 | 74 | 2102 | MANURE | FEEDLOT MANURE-SUDDENLY IT S WORTH MORE KEYWORDS FERTILIZERS NITROGEN PHOSPHORUS POTA |
| 600 | 74 | 2119 | MANURE | CHEMICAL CONTROL OF MANURE ODOR KEYWORDS ODOR ENZYMES CHEMICAL-ODOR-CONTROL MANURE MA |
| 700 | 72 | 2127 | MANURE | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 200 | 74 | 2146 | MANURE | EFFECT OF HOUSING TYPE ON NUTRIENT COMPOSITION OF BEEF CATTLE MANURE KEYWORDS HOUSING |
| 200 | 63 | 2164 | MANURE | SANITARY LANDFILLING OF POULTRY WASTES KEYWORDS POULTRY SOLID-WASTES COSTS MANURE SAN |
| 100 | 72 | 2170 | MANURE | DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION KEYWORD |
| 200 | 74 | 2185 | MANURE | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 100 | 74 | 2189 | MANURE | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 700 | 69 | 2225 | MANURE | AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON THE AGITATION AND REMOVAL O |
| 400 | 72 | 2230 | MANURE | MANURE DECREASES NEED FOR FERTILIZER KEYWORDS FERTILIZERS NUTRIENTS MANURE TILTH CROP |
| 100 | 74 | 2253 | MANURE | ELEMENTAL COMPOSITION OF PARTICULATES NEAR A BEEF CATTLE FEEDLOT KEYWORDS DUSTS FEEDL |
| 400 | 71 | 2269 | MANURE | MANURE ON MILLET KEYWORDS AMMONIA TOXICITY NITRATES MANURE MILLET APPLICATION-RATES |
| 100 | 73 | 2277 | MANURE | LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A |
| 300 | 75 | 2284 | MANURE | PROFITS FROM DAIRY MANURE APPLICATION KEYWORDS DAIRY-INDUSTRY COSTS PROFITS LIQUID-MA |
| 400 | 72 | 2289 | MANURE | MOLASSES FROM MANURE KEYWORDS FEEDS SLUDGE PROTEINS MANURE MOLASSES SULPHUR-DIOXIDE |
| 400 | 70 | 22[illegible]1 | MANURE | FLY PUPAE HIGH QUALITY PROTEIN SUPPLEMENT KEYWORDS FEEDS PROTEINS FERTILIZERS FLY-PU |
| 400 | 72 | 2303 | MANURE | CHICKENS CONTROL FLIES FROM MANURE STACK KEYWORDS POULTRY DAIRY-INDUSTRY FLY-CONTROL |
| 300 | 72 | 2313 | MANURE | FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES-IN |
| 700 | 68 | 2317 | MANURE | FERTILIZING VALUE OF CATTLE MANURE IN RELATION TO TREATMENT AND METHOD OF HANDLING KEY |
| 400 | 75 | 2322 | MANURE | NEW MANURE CONVERSION PLANT OPENED KEYWORDS RECYCLING FERTILIZERS FEEDS AEROBIC-DIGES |
| 400 | 75 | 2324 | MANURE | WASTE CONVERSION CONCEPT DEVELOPED KEYWORDS RECYCLING AEROBIC-CONDITIONS BACTERIA CAT |
| 100 | 72 | 2328 | MANURE | THE OIL CONVERSION PROCESS-AN ASSESSMENT KEYWORDS RECYCLING OIL LIVESTOCK AGRICULTURAL |
| 100 | 73 | 2332 | MANURE | ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS KEYWORD |
| 400 | 75 | 2336 | MANURE | ORGANIC WASTES-ONCE NUISANCES-NOW RESOURCES KEYWORDS ORGANIC-WASTES FERTILIZERS SOIL-A |
| 100 | 74 | 2337 | MANURE | MANURE GETS REDISCOVERED KEYWORDS FEEDLOTS FERTILIZERS LIVESTOCK COSTS [illegible] NITRATE |
| 100 | 74 | 2340 | MANURE | RESULTS FROM EXPERIMENTS MEASURING THE EFFECTS OF LARGE AMOUNTS OF FERTILIZER AND OF FA |
| 400 | 75 | 2346 | MANURE | CONSEQUENCES OF WASTE DISPOSAL ON LAND KEYWORDS WASTE-DISPOSAL ORGANIC-WASTES SEWAGE- |
| 400 | 75 | 2351 | MANURE | POULTRY LITTERS VALUE AS FERTILIZER CITED BY GEORGIAN KEYWORDS POULTRY LITTER FERTILIZ |
| 400 | 61 | 2380 | MANURE | MANURE SMELL FURNISHES FARMSTEADS POWER NEEDS KEYWORDS GASES FERTILIZERS ANAEROBIC-DIG |
| 200 | 70 | 2397 | MANURE | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 100 | 69 | 2400 | MANURE | RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE KEYWORDS FARM-WAST |
| 700 | 70 | 2406 | MANURE | EFFECT OF ANTIBIOTIC SUPPLEMENTATION ON THE DECOMPOSITION OF ANIMAL WASTES KEYWORDS A |
| 100 | 65 | 2427 | MANURE | VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL KEYWORDS NUTRIENTS NITROGEN PHOSPHORUS |
| 200 | 74 | 2457 | MANURE | PROCEEDINGS OF SYMPOSIUM ON THE CONVERSION OF POULTRY WASTE TO ENERGY FEED OR FERTILIZE |
| 200 | 74 | 2490 | MANURE | THE MECHANICS OF AIR DRYING KEYWORDS POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB |
| 100 | 75 | 2492 | MANURE | EFFECTS OF BEEF FEEDLOT MANURE AND LAGOON WATER ON IRON ZINC MANGANESE AND COPPER CONTE |
| 100 | 70 | 2520 | MANURE | POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANU |
| 100 | 73 | 2521 | MANURE | SOME EFFECTS OF FERTILIZERS AND FARMYARD MANURE ON THE ORGANIC PHOSPHORUS IN SOILS KEY |
| 700 | 72 | 2560 | MANURE | THE EFFECT OF DEHYDRATION ON THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF MANURE OF |
| 100 | 75 | 2590 | MANURE | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 200 | 75 | 2592 | MANURE | ECONOMICS OF SUBSTITUTION AND THE DEMAND FOR BEEF FEEDLOT WASTES-ONE ALTERNATIVE FOR SO |
| 400 | 74 | 2776 | MANURE | ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES KEYWORDS ENERGY FUE |
| 100 | 73 | 2779 | MANURE | HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE KEYWORDS COMPOSTING MUNIC |
| 100 | 71 | 2782 | MANURE | LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS KEYWORDS COMPUTER-MODELS WASTE- |
| 200 | 72 | 2785 | MANURE | MANURE HANDLING CAPACITY OF SOILS FROM A MICROBIOLOGICAL POINT OF VIEW KEYWORDS SOILS |
| 100 | 71 | 2787 | MANURE | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 700 | 73 | 2792 | MANURE | THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE KE |
| 400 | 72 | 1043 | MANURE-APPLICATION | WATER INTAKE RATES ON A SILT LOAM SOIL WITH VARIOUS MANURE APPLICATIONS KEYWORDS [illegible] |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

# KEYWORD INDEX

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630 74 2119  MATCHING-STANDARDS CHEMICAL CONTROL OF MANURE ODOR  KEYWORDS  ODOR ENZYMES CHEMICAL-ODOR-CONTROL MANURE MA
602 71 1737  MATERIALS          SLOTTED FLOORS FOR HOGS-PROGRESS AND TRENDS  KEYWORDS  SWINE DESIGN CONSTRUCTION SLOTTE
303 73 1835  MATERIALS          STRUCTURES AND ENVIRONMENT HANDBOOK  KEYWORDS  PLANNING ENVIRONMENT WASTE-DISPOSAL DESI
200 69 1984  MATERIAL           A REVIEW OF AVAILABLE LITTER MATERIALS AND THEIR ADVANTAGES AND DISADVANTAGES  KEYWORDS
700 69 1656  MATHEMATICAL-MODEL MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF  KEYWORDS  MATHEMATI
200 74 1777  MATHEMATICAL-MODEL MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES  KEY
400 73 1858  MATHEMATICAL-MODEL FERMENTATION HEADS FOR HIGHER PRODUCTIVITY  KEYWORDS FERMENTATION RECYCLING WASTE-TREAT
100 71 1936  MATHEMATICAL-MODEL TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM MEASUREMENT OF DIFFUSIVITY IN CATTLE
600 74 1961  MATHEMATICAL  ODEL SIMULATION OF MISCIBLE DISPLACEMENT IN SOILS  KEYWORDS  INFILTRATION MATHEMATICAL-MODELS
200 74 1997  MATHEMATICAL-MODEL METHODS FOR IDENTIFYING AND EVALUATING THE NATURE AND EXTENT OF NONPOINT SOURCES OF POL
200 74 2004  MATHEMATICAL-MODEL EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATIO
200 74 2013  MATHEMATICAL-MODEL ENERGY AND MONETARY COSTS FOR TWO BEEF CATTLE WASTE DISPOSAL SYSTEMS  KEYWORDS  ENERGY
200 74 2023  MATHEMATICAL-MODEL A FUNDAMENTAL APPROACH TO ANAEROBIC LAGOON ANALYSIS  KEYWORDS  MATHEMATICAL-MODELS ANAL
700 69 2120  MATHEMATICAL-MODEL ANAEROBIC DIGESTION OF CHICKEN MANURE  KEYWORDS  ANAEROBIC-DIGESTION POULTRY MATHEMATI.
100 72 2170  MATHEMATICAL-MODEL DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION  KEYWORD
700 67 2363  MATHEMATICAL-MODEL ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE  KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S
200 75 2741  MATHEMATICAL-MODEL SIMULATION OF FUNDAMENTAL ANAEROBIC LAGOON KINETICS KEYWORDS  MODEL-STUDIES MATHEMATICA
100 74 2784  MATHEMATICAL-MODEL REGIONAL MANAGEMENT OF ANIMAL MANURES-A MODEL FOR COLLECTION STORAGE LOCATION AND DISTR
100 72 1621  MEASUREMENT        SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW  KEYWORDS  FEEDLOTS ODOR-
300 74 1629  MEASUREMENT        CONTROL OF DUST FROM CATTLE FEEDLOTS  KEYWORDS  CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN
200 73 1648  MEASUREMENT        ODOR INTENSITIES AT CATTLE FEEDLOTS  KEYWORDS  ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC
700 69 1650  MEASUREMENT        CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS  CHEMICAL-OXYGEN-D
100 73 1685  MEASUREMENT        SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH
100 73 1793  MEASUREMENT        DISPERSION DURING FLOW IN POROUS MEDIA WITH BILINEAR ADSORPTION  KEYWORDS  DISPERSION F
300 73 1851  MEASUREMENT        ODORS FROM LIVESTOCK PRODUCTION  KEYWORDS  ODOR LIVESTOCK AMMONIA MEASUREMENT ODOR-CONT
100 71 1936  MEASUREMENT        TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM MEASUREMENT OF DIFFUSIVITY IN CATTLE
200 74 1997  MEASUREMENT        METHODS FOR IDENTIFYING AND EVALUATING THE NATURE AND EXTENT OF NONPOINT SOURCES OF POL
300 74 2248  MEASUREMENT        IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR
300 71 2286  MEASUREMENT        IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS  KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE
700 72 2321  MEASUREMENT        QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR  KEYWORDS  ODOR VOL
100 73 2332  MEASUREMENT        ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS  KEYWORD
100 74 2450  MEASUREMENT        ODOR REDUCTION FOR LIQUID MANURE SYSTEMS  KEYWORDS  ODOR MEASUREMENT LIQUID-WASTES INJE
200 75 2605  MEASUREMENT        MODIFICATIONS OF THE MICHIGAN STATE POULTRY IN-HOUSE DRYING SYSTEM  KEYWORDS  DESIGN MO
200 75 2689  MEASUREMENT        IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR
200 75 2690  MEASUREMENT        QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR  KEYWORDS  ODOR MEA
200 73 2480  MECHANICALLY-AERAT AEROBIC TREATMENT OF LIVESTOCK WASTES  KEYWORDS  AEROBIC-TREATMENT LIVESTOCK DESIGN ENG
700 68 1037  MECHANICAL-AERATOR A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE OXIDAT. SYSTEM A
200 73 2432  MECHANICAL-AERATOR LIVESTOCK WASTE MANAGEMENT CONFERENCE  KEYWORDS  LIVESTOCK  ILLINOIS LEGAL-ASPECTS FEED
200 73 2437  MECHANICAL-AERATOR OXYGENATION AND FLOW CHARACTERISTICS OF MECHANICAL AERATORS KEYWORDS  AERATION OXYGENAT
100 66 2079  MECHANICAL-CONTROL ODOR CONTROL IN CATTLE FEED YARDS  KEYWORDS  ODOR MECHANICAL-CONTROL LEGAL-ASPECTS SPRA
100 72 2550  MECHANIZED-BIOLOGI TREATMENT OF DAIRY WASTES BY MECHANIZED BIOLOGICAL METHODS KEYWORDS  WASTE-TREATMENT D
600 72 1951  MECHANIZED-COMPOST A MECHANIZED COMPOST CHANNEL FOR ANIMAL WASTE  KEYWORDS DESIGN-DATA MECHANIZED-COMPOST-
700 71 2507  MEMBRANE-FILTER    FECAL COLIFORM POLLUTION IN AN AGRICULTURAL [illegible] KEYWORDS  WATER-POLLUTION AGRIC
200 75 2747  MEMBRANE-SEPARATIO TERTIARY TREATMENT OF ANIMAL WASTEWATERS BY REVERSE OSMOSIS MEMBRANES  KEYWORDS  TERTIA
600 72 1667  MESOPHILIC-BACTERI THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES  KEYWORDS  THERMOPHI
600 74 2050  MESOPHILIC-SOLAR-R METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR  KEYWORDS  METHANE FEASIBILITY-S
600 74 2404  METABOLIC-WASTE-PR CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH  KEYWORDS
100 73 1673  METABOLISM         TROUT METABOLISM CHARACTERISTICS AND THE RATIONAL DESIGN OF NITRIFICATION FACILITIES FO
600 71 1716  METABOLISM         BIOLOGY OF WASTE MANAGEMENT  KEYWORDS  BIOLOGY WASTE-MANAGEMENT MICROORGANISMS METABOLI
600 74 2404  METABOLISM         CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH  KEYWORDS
300 72 2086  METEOROLOGY        HYDROLOGY AND CHARACTERISTICS OF FEEDLOT RUNOFF  KEYWORDS  HYDROLOGY FEEDLOTS AGRICULTUR
400 74 1810  METHANE            MONFORT FUELS FEEDLOT AND PLANT WITH MANURE  KEYWORDS  FUELS METHANE FEEDLOTS WASTE-TREA
400 73 1835  METHANE            AGRICULTURAL WASTES  KEYWORDS  LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC
200 74 1867  METHANE            SURMOUNTING THE POULTRY WASTE PROBLEM  KEYWORDS  POULTRY EXCRETA WASTE-MANAGEMENT ANAER
400 74 1926  METHANE            COOKING WITH COW POWER  KEYWORDS  METHANE ANAEROBIC-BACTERIA CATTLE FERTILIZERS RECYCLI
400 74 1933  METHANE            METHANE PRODUCTION NOT EASY OR PRACTICAL  KEYWORDS  METHANE [illegible] CATTLE RECYCLING ENG
[illegible]
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| | | | | |
|---|---|---|---|---|
| 100 | 74 | 2104 | METHANE-BACTERIA | METHANE PRODUCTION FROM WASTE KEYWORDS METHANE METHANE-BACTERIA SEWAGE WASTE-TREATMEN |
| 400 | 74 | 2114 | METHANE-COSTS | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 600 | 74 | 2050 | METHANE-DIGESTION | METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR KEYWORDS METHANE FEASIBILITY-S |
| 100 | 73 | 2431 | METHIONINE | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 100 | 72 | 1700 | METHODOLOGY | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 600 | 69 | 1041 | METHODOLOGY | A PROCEDURE TO IDENTIFY MALODORS FROM ANIMAL WASTES KEYWORDS ODOR GAS-CHROMATOGRAPHY S |
| 302 | 74 | 2517 | METHODOLOGY | POLLUTED GROUNDWATER-ESTIMATING THE EFFECTS OF MANS ACTIVITIES KEYWORDS FEEDLOTS INDU |
| 300 | 69 | 1706 | METHEMOGLOBINEMIA | NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWORDS NITRATES NITRITES POLLUTANTS WATER |
| 100 | 71 | 1020 | METHYL-BROMIDE | THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID |
| 600 | 73 | 1602 | MICHIGAN | POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN KEYWORDS FAR |
| 200 | 74 | 2135 | MICHIGAN | AGRICULTURAL WASTE CONFERENCE KEYWORDS ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC |
| 200 | 74 | 2136 | MICHIGAN | ANIMAL WASTE SYSTEMS KEYWORDS FEEDLOTS CONFINEMENT-PENS MICHIGAN WASTE-STORAGE WASTE- |
| 200 | 74 | 2139 | MICHIGAN | ODOR PROBLEMS ASSOCIATED WITH AGRICULTURAL WASTE HANDLING KEYWORDS ODOR MICHIGAN AIR-P |
| 200 | 74 | 2140 | MICHIGAN | ECONOMIC IMPACT OF SELECTED POLLUTION CONTROL MEASURES ON BEEF AND DAIRY FARMS KEYWORD |
| 200 | 74 | 2141 | MICHIGAN | MICHIGAN S ENVIRONMENTAL CONTROL PROGRAM AND ORGANIZATION KEYWORDS MICHIGAN WATER-POLL |
| 200 | 74 | 2147 | MICHIGAN | PENDING LEGISLATION RELATED TO AGRICULTURAL WASTE KEYWORDS MICHIGAN LEGISLATION WASTE-A |
| 303 | 71 | 2421 | MICHIGAN | WHOSE RESPONSIBILITY-CONTROL OF LIVESTOCK AND POULTRY WASTES KEYWORDS WASTE-DISPOSAL |
| 800 | 73 | 2516 | MICHIGAN | IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS KEYWORDS MICHIGAN DAIRY-INDUSTRY LEGAL |
| 600 | 75 | 2559 | MICHIGAN | COMPARISON OF DESIGN CRITERIA AND PERFORMANCE OF WASTE HANDLING SYSTEMS KEYWORDS DESI |
| 400 | 72 | 2581 | MICHIGAN | WASTE MANAGEMENT PRACTICES AND SYSTEMS ON MICHIGAN DAIRY FARMS KEYWORDS MICHIGAN REGU |
| 400 | 72 | 2573 | MICHIGAN | A LIVESTOCKMANS GUIDE TO POLLUTION LAWS KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT |
| 201 | 75 | 2603 | MICHIGAN | THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION |
| 200 | 75 | 2605 | MICHIGAN | MODIFICATIONS OF THE MICHIGAN STATE POULTRY IN-HOUSE DRYING SYSTEM KEYWORDS DESIGN MI |
| 200 | 75 | 2608 | MICHIGAN | CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE KEYWORD |
| 200 | 72 | 2947 | MICROBES | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 700 | 72 | 2127 | MICROBIAL-ACTIVITY | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 500 | 74 | 2503 | MICROBIAL-CONTAMIN | THE RECYCLING OF ORGANIC WASTE-INTENSIVE CATTLE PRODUCTION KEYWORDS RECYCLING CHLORE |
| 400 | 73 | 1748 | MICROBIAL-DECOMPOS | IS TOTAL RECYCLING OF HEN MANURE POSSIBLE KEYWORDS POULTRY RECYCLING FERMENTATION DIG |
| 100 | 72 | 2357 | MICROBIAL-DEGRADAT | MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES KEYWORDS MICROBIAL |
| 100 | 75 | 2437 | MICROBIAL-DEGRADAT | SOLIDS REDUCTION OF BEEF CATTLE WASTES IN A SEPARATED PROCESS OXIDATION DITCH KEYWORDS |
| 200 | 72 | 2743 | MICROBIAL-DEGRADAT | MANURE HANDLING CAPACITY OF SOILS FROM A MICROBIOLOGICAL POINT OF VIEW KEYWORDS SOILS |
| 700 | 72 | 2329 | MICROBIAL-ECOLOGY | THE MICROBIAL ECOLOGY OF CULTIVATED SOIL RECEIVING COW MANURE WASTE KEYWORDS FARM-WAS |
| 600 | 72 | 2074 | MICROBIAL-FOOD | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS THE |
| 200 | 68 | 1643 | MICROBIOLOGY | MICROBIOLOGICAL ASPECTS OF POULTRY WASTES KEYWORDS EXCRETA POULTRY MICROBIOLOGY NUTRIE |
| 700 | 71 | 1665 | MICROBIOLOGY | MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM WASTE LAGOON KEYWORDS FAR |
| 100 | 74 | 2104 | MICROBIOLOGY | METHANE PRODUCTION FROM WASTE KEYWORDS METHANE METHANE-BACTERIA SEWAGE WASTE-TREATMEN |
| 100 | 73 | 2579 | MICROBIOLOGY | MICROBIOLOGY IN THE AEROBIC TREATMENT OF FARM WASTES KEYWORDS MICROBIOLOGY AEROBIC-TRE |
| 200 | 75 | 2646 | MICROBIOLOGY | MICROBIOLOGICAL AND CHEMICAL ANALYSES OF [illegible] IN A COMPLETE LAYER EXCRETA IN-HOUSE |
| 100 | 61 | 2505 | MICROFLORA | THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI |
| 400 | 74 | 2102 | MICRONUTRIENTS | FEEDLOT MANURE-SUDDENLY IT S WORTH MORE KEYWORDS FERTILIZERS NITROGEN PHOSPHORUS POTA |
| 600 | 73 | 1724 | MICROORGANISMS | BIOLOGY OF WASTE MANAGEMENT KEYWORDS BIOLOGY WASTE-MANAGEMENT MICROORGANISMS METABOLI |
| 600 | 71 | 1720 | MICROORGANISMS | NATURE AND BEHAVIOR OF MANURE KEYWORDS WATER-POLLUTION FEEDLOTS AGRICULTURAL-RUNOFF M |
| 600 | 74 | 1748 | MICROORGANISMS | FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS FLOCCULATION CATTLE PL |
| 100 | 72 | 1700 | MICROORGANISMS | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 700 | 71 | 1864 | MICROORGANISMS | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 210 | 74 | 2008 | MICROORGANISMS | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 200 | 69 | 2162 | MICROORGANISMS | WATER POLLUTION PREVENTION KEYWORDS WATER-POLLUTION GROUNDWATER LIVESTOCK POULTRY AGR |
| 700 | 70 | 2404 | MICROORGANISMS | EFFECT OF ANTIBIOTIC SUPPLEMENTATION ON THE DECOMPOSITION OF ANIMAL WASTES KEYWORDS A |
| 100 | 74 | 2561 | MICROORGANISMS | RECOVERING PROTEIN FROM DAIRY CATTLE WASTES KEYWORDS PROTEINS DAIRY-INDUSTRY SEPARATIO |
| 100 | 71 | 2570 | MICROORGANISMS | BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN KEYWORDS MICROORGANISMS TOXICITY POULT |
| 100 | 73 | 2579 | MICROORGANISMS | MICROBIOLOGY IN THE AEROBIC TREATMENT OF FARM WASTES KEYWORDS MICROBIOLOGY AEROBIC-TRE |
| 200 | 75 | 2586 | MICROORGANISMS | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS HA |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

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[illegible] 72 2575 MISSOURI        A LIVESTOCKMANS GUIDE TO POLLUTION LAWS  KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT
[illegible]    2777 MISSOURI        GROUND WATER CONTAMINATION BY DISSOLVED NITRATE  KEYWORDS NITRATES FERTILIZERS GEOCHEMI
[illegible] 73 1092 MISSOURI-APPROACH IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI  KEY
[illegible] 74 1671 MODELS          PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS  KEYWORDS  FEEDLOTS AGRICULT
[illegible] 75 2537 MODEL           MODEL TO PREDICT THE PERFORMANCE OF FEEDLOT CONTROL FACILITIES AT SPECIFIC OREGON LOCAT
[illegible] 72 1650 MODEL-STUDIES   CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM AGRICULTURAL  LANDS  KEYWORDS  SEDIMENT-C
[illegible] MODEL-STUDIES           SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH
[illegible] MODEL-STUDIES           MOVEMENT OF MANURIAL NITROGEN IN COOL HUMID CLIMATES KEYWORDS  MODEL-STUDIES NITROGEN M
[illegible] MODEL-STUDIES           THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS  KEYWORDS  NITROGEN FEEDLOTS SOILS CAT
[illegible] MODEL-STUDIES           SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF
[illegible] MODEL-STUDIES           ELECTRICALLY [illegible] WASTE FROM CAGED LAYERS  KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL
[illegible] MODEL-STUDIES           A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM A
[illegible] MODEL-STUDIES           WATER POLLUTION POTENTIAL OF CATTLE FEEDLOT RUNOFF  KEYWORDS  FEEDLOTS AGRICULTURAL-RUN
[illegible] MODEL-STUDIES           EFFECT OF SLOTTED FLOORS ON AIR FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILD
[illegible] MODEL-STUDIES           AN ECONOMIC ANALYSIS OF POLICIES TO CONTROL NUTRIENT AND SOIL LOSSES FROM A SMALL WATER
[illegible] MODEL-STUDIES           BEEF WASTE MANAGEMENT ECONOMICS FOR MINNESOTA FARMER FEEDERS  KEYWORDS  MINNESOTA REGUL
[illegible] MODEL-STUDIES           THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL  OF ATMOSPHERIC GASEOUS CONT
[illegible] MODEL-STUDIES           AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON  THE AGITATION AND REMOVAL O
[illegible] MODEL-STUDIES           A MODEL STUDY OF FLOW VELOCITIES IN AN OXIDATION DITCH KEYWORDS  MODEL-STUDIES DESIGN O
[illegible] MODEL-STUDIES           SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL  KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS
[illegible] MODEL-STUDIES           EFFECTS OF ENVIRONMENTAL LEGISLATION ON CATTLE FEEDLOT LOCATION  KEYWORDS  MODEL-STUDIE
[illegible] MODEL-STUDIES           ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS I
[illegible] MODEL-STUDIES           MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN  COLD CLIMATES  KEYWORDS  IR
[illegible] MODEL-STUDIES           HIGH RATE MECHANIZED COMPOSTING OF DAIRY MANURE KEYWORDS  DESIGN MODEL-STUDIES COMPOSTI
[illegible] MODEL-STUDIES           A DESIGN APPROACH FOR THE USE OF AN OXIDATION DITCH FOR LIVESTOCK WASTE TREATMENT  KEYW
[illegible] MODEL-STUDIES           A THEORETICAL DESCRIPTION OF AEROBIC TREATMENT  KEYWORDS AEROBIC-TREATMENT POULTRY MODE
[illegible] MODEL-STUDIES           SIMULATION OF FUNDAMENTAL ANAEROBIC LAGOON KINETICS KEYWORDS  MODEL-STUDIES MATHEMATICA
[illegible]                         [illegible] CASE FOR CONFINEMENT  KEYWORDS  CONFINEMENT-PENS CATTLE LAGOONS COSTS WASTE-
[illegible]                         COMPARATIVE CHANGES IN SOIL PHYSICAL PROPERTIES INDUCED BY  ADMIXTURES OF MANURE FROM V
[illegible]                         PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE F
[illegible] MOISTURE                CONTROL OF DUST FROM CATTLE FEEDLOTS  KEYWORDS  CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN
[illegible] MOISTURE                ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING  KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC
[illegible] MOISTURE                [illegible] CATTLE FEEDLOTS  KEYWORDS  ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC
[illegible] MOISTURE                HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS  KEYWORDS  DES
[illegible] MOISTURE                DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA  KEYWORDS DIGESTION FARM-WASTES POULTRY
[illegible] MOISTURE                AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON  THE AGITATION AND REMOVAL O
[illegible] MOISTURE                NITROGEN LOSS FROM MANURE AS INFLUENCED BY MOISTURE AND TEMPERATURE  KEYWORDS  NITROGEN
[illegible] MOISTURE                POULTRY LITTER [illegible] AS FERTILIZER CITED BY GEORGIAN KEYWORDS  POULTRY LITTER FERTILIZ
[illegible] MOISTURE                PHYSICAL PROPERTIES OF A COLD SILTY CLAY LOAM SOIL DURING TWO YEARS IRRIGATION WITH EFF
[illegible] MOISTURE-CONTENT        ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE  K
[illegible] MOISTURE-CONTENT        THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID
[illegible] MOISTURE-CONTENT        VACUUM FILTRATION OF CATTLE MANURE  KEYWORDS  VACUUM-FILTRATION SLURRIES SLUDGE MOISTUR
[illegible] MOISTURE-CONTENT        EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE  KEYWORDS  MOISTURE-CO
[illegible] MOISTURE-CONTENT        EFFECT OF SPRINKLING ON LIQUID ANIMAL WASTE PROPERTIES KEYWORDS  SPRINKLING LIQUID-WAST
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[illegible] MOISTURE-CONTENT        [illegible] POULTRY MANURE  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL POULTRY NUTR
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[illegible] MOISTURE-CONTENT        [illegible] COMPOSTING  KEYWORDS  AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST
[illegible] MOISTURE-CONTENT        [illegible] OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL
[illegible] MOISTURE-CONTENT        [illegible] AIR DRYING  KEYWORDS  POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB
[illegible] MOISTURE-CONTENT        [illegible] KEYWORDS  SEPARATION-TECHNIQUES SOLID-WASTES SLURRIES SETTLING-BASIN
[illegible] MOISTURE-CONTENT        [illegible] CHARACTERISTICS OF ANIMAL WASTE  KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES
[illegible] MOISTURE-CONTENT        [illegible] FOR FEEDLOT MANURE-A CONCEPTUAL DESIGN STUDY KEYWORDS  DESIGN  EQUIPMENT
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[illegible] MOISTURE-CONTENT        [illegible] AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE
[illegible] MOISTURE-CONTENT        [illegible] ISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA  KEYWORDS  POULTRY DRYIN
[illegible] MOISTURE-CONTENT        [illegible] PHYSICAL PROPERTIES OF PIG MANURE  KEYWORDS PHYSICAL-PROPERTIES EVALUATED
[illegible]                         [illegible] BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK
[illegible]                         [illegible] WASTE FROM CAGED LAYERS  KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL
[illegible]                         [illegible] KEYWORDS  FEEDS SLUDGE PROTEINS MANURE MOLASSES SULPHUR-DIOXIDE
[illegible] MOLDS                   [illegible] FLAKES AS AN ANTIMICROBIAL AGENT IN BUILT UP POULTRY LITTER  KE
[illegible] MOLDS                   [illegible] POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS  BACTERIA MOLDS YEASTS LI
[illegible]                         [illegible] MUCK TO MEALS  KEYWORDS  FEEDS RECLAMATION  EFFLUENT FISH ALGAE MOLLUSK
[illegible]                         [illegible] OF SOME COMMON MINNESOTA FEEDS  KEYWORDS FEEDS MINNESOTA ANALYSES PHOS
[illegible] MONITORING              [illegible] WASTE MANAGEMENT SYSTEMS  KEYWORDS MONITORING FARM-WASTES MANAGEMENT
[illegible] MONITORING              [illegible] OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS  KEYWORDS  CATTLE WAS
[illegible] MONITORING              [illegible] FARMER  KEYWORDS  FISH-FARMING REGULATIONS  EFFLUENT PONDS SUSPENDED-S
[illegible]                         [illegible] SCRIPTION OF AEROBIC TREATMENT  KEYWORDS AEROBIC-TREATMENT POULTRY MODE
[illegible] MONTANA                 [illegible] KEYWORDS  FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION
[illegible] MONTANA                 [illegible] DISPOSAL IN MONTANA  KEYWORDS WATER-QUALITY WASTE-DISPOSAL MONT
[illegible] MONTANA                 [illegible] OF NEW IDEAS  KEYWORDS  DAIRY-INDUSTRY DESIGN MONTANA ODOR VENTIL
[illegible] MONTANA                 [illegible] POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED  STATES  KEYWORDS  [illegible]
[illegible] MONTANA                 [illegible] AND RECOMMENDATIONS IN ANIMAL WASTE MANAGEMENT CONTROL MEASURES FOR
[illegible] MONTANA                 [illegible] CATTLE FEEDLOT DESIGN  KEYWORDS  FEEDLOTS DESIGN-CRITERIA MONTANA ENGINE
[illegible] MONTANA                 [illegible] UNDER STUDY AT MSU-ANIMAL WASTE MANAGEMENT  KEYWORDS  [illegible]
[illegible] MORTALITY               [illegible] KEYWORDS  MANURE GASES CATTLE [illegible] MORTALITY SLOTTED
[illegible] MORTALITY               [illegible] NOT TOO EFFICIENT IN LAYING HEN FEEDS KEYWORDS  POULTRY FEEDS DIET
[illegible] MORTALITY               [illegible] ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE  KEYWORDS  FEEDS [illegible]
[illegible] MORTALITY               [illegible] OF WHITE LEGHORN MANURE  KEYWORDS  FEEDS MORTALITY MOISTURE-CONTENT WH
[illegible] MORTALITY               [illegible] OF FEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION
[illegible] MOSQUITOES              [illegible] IN LIVESTOCK WASTE LAGOONS IN ILLINOIS [illegible]  KEYWORDS  LAGOONS MOSQUIT
[illegible]                         [illegible] WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COORD
[illegible]                         [illegible] AND CONTROL IN ANIMAL WASTE LAGOONS KEYWORDS  MOSQUITOES LAGOONS IN
[illegible]                         [illegible] OF SWINE WASTE LAGOONS BEFORE AND AFTER ARTIFICIAL AERATION  KEYWORDS
[illegible]                         [illegible] MANAGEMENT CONFERENCE  KEYWORDS  LIVESTOCK  ILLINOIS LEGAL-ASPECTS [illegible]
[illegible]                         [illegible] AND CONTROL IN ANIMAL WASTE LAGOONS KEYWORDS  MOSQUITOES LAGOONS IN
[illegible]                         [illegible] SYSTEMS  KEYWORDS  FEEDLOTS CATTLE KANSAS WASTE-MANAGEMENT [illegible]
[illegible]                         [illegible] MANAGEMENT-WHY AND HOW  KEYWORDS  FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON
[illegible]                         [illegible] AS A RESOURCE-NOT A WASTE  KEYWORDS  WATER-POLLUTION AGRICULTURAL-RUNOFF
[illegible]                         [illegible] NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE [illegible]  KEYWORDS  FEEDS
[illegible]                         [illegible] FEEDLOT MANAGEMENT  KEYWORDS  FEEDLOTS DESIGN AGRICULTURAL-RUNOFF [illegible]
[illegible]                         [illegible] OF TOTAL NITROGEN IN COOL HUMID CLIMATES KEYWORDS  MODEL-STUDIES NITROGEN M
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# KEYWORD INDEX

| | | |
|---|---|---|
| 200 74 1777 | MOVEMENT | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 600 73 1848 | MOVEMENT | MODEL OF NITRATE PRODUCTION AND MOVEMENT IN MANURE DISPOSAL PLOTS KEYWORDS COMPUTER-M |
| 200 71 1964 | MOVEMENT | MOVEMENT OF GROUND WATER KEYWORDS GROUNDWATER-POLLUTION MOVEMENT WASTE-DISPOSAL ANIMA |
| 100 74 2131 | MOVEMENT | THE EFFECT OF LARGE APPLICATIONS OF MANURE ON MOVEMENT OF NITRATE AND CARBON IN AN IRRI |
| 200 73 2475 | MUD | OUTDOOR UNPAVED FEEDLOT MANAGEMENT KEYWORDS FEEDLOTS DESIGN AGRICULTURAL-RUNOFF DRAIN |
| 200 73 2440 | MUNICIPAL-DIGESTER | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
| 400 74 2336 | MUNICIPAL-SLUDGE | MUNICIPAL SLUDGE IN SWINE MANURE HELPS CONTROL ODORS KEYWORDS WASTE-TREATMENT ODOR-CON |
| 200 74 1649 | MUNICIPAL-WASTES | COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE KEYWORDS MUNICIPAL-WASTES FEEDLOTS FARM-W |
| 600 71 1717 | MUNICIPAL-WASTES | AEROBIC WASTE TREATMENT KEYWORDS AEROBIC-TREATMENT OXIDATION-LAGOONS AERATED-LAGOONS |
| 300 71 1882 | MUNICIPAL-WASTES | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 200 72 1908 | MUNICIPAL-WASTES | A STATUS REPORT ON AGRICULTURAL AND MUNICIPAL WASTE TREATMENT LAGOONS IN MISSISSIPPI K |
| 200 74 1986 | MUNICIPAL-WASTES | DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS WASTE-DISPOSAL RE |
| 100 74 2075 | MUNICIPAL-WASTES | FUEL FROM LIVESTOCK WASTES-AN ECONOMIC ANALYSIS KEYWORDS FUELS ORGANIC-WASTES ECONOMIC |
| 100 72 2357 | MUNICIPAL-WASTES | MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES KEYWORDS MICROBIAL |
| 300 75 2426 | MUNICIPAL-WASTES | USE OF SLUDGE RELIEVES FERTILIZER SHORTAGE KEYWORDS RECYCLING ENERGY FERTILIZERS SLUDG |
| 100 73 2779 | MUNICIPAL-WASTES | HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE KEYWORDS COMPOSTING MUNIC |
| 100 68 2788 | MUNICIPAL-WASTES | THE FLOW OF SOLID WASTES IN PIPELINES KEYWORDS SOLID-WASTES HYDRAULIC-TRANSPORTATION P |
| 400 72 2795 | MUNICIPAL-WASTES | FINALLY A CREATIVE PROFITABLE SOLUTION TO AGE OLD WASTE PROBLEM KEYWORDS CATTLE MUNIC |
| 100 74 2288 | MUNICIPAL-WATERS | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 100 74 2189 | MUSCA-DOMESTICA | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 100 73 2325 | MUSCA-DOMESTICA-L | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 100 71 2767 | MYCOLOGY | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 400 74 1808 | NATURAL-GAS | MONFORT FUELS FEEDLOT AND PLANT WITH MANURE KEYWORDS FUELS METHANE FEEDLOTS WASTE-TREA |
| 400 74 1909 | NATURAL-GAS | COOKING WITH COW POWER KEYWORDS METHANE ANAEROBIC-BACTERIA CATTLE FERTILIZERS RECYCLI |
| 300 72 1628 | NEBRASKA | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 100 73 1663 | NEBRASKA | INFLUENCE OF AGRICULTURAL PRACTICES ON WATER QUALITY IN NEBRASKA A SURVEY OF STREAMS GR |
| 100 73 1664 | NEBRASKA | A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED |
| 600 74 1684 | NEBRASKA | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 400 73 1817 | NEBRASKA | FLUSH SYSTEM CUTS CONFINEMENT COSTS KEYWORDS CONFINEMENT-PENS CATTLE COSTS FLUSH-SYST |
| 100 74 1821 | NEBRASKA | IRRIGATION OF PERENNIAL FORAGE CROPS WITH FEEDLOT RUNOFF KEYWORDS IRRIGATION AGRICULTU |
| 400 70 1947 | NEBRASKA | LITTLE POLLUTION FROM THIS FEEDLOT KEYWORDS FEEDLOTS NEBRASKA ANALYSIS NITRATES GASES |
| 200 71 1978 | NEBRASKA | LARGE COMMERCIAL FEEDLOTS HOW WASTES ARE HANDLED IN THE WEST KEYWORDS FEEDLOTS NEBRASK |
| 700 73 2061 | NEBRASKA | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF KEYWORDS BIOLOGICAL-TREATMENT AGRICULTURAL-RUN |
| 100 74 2130 | NEBRASKA | EFFECT OF EFFLUENT FROM BEEF FEEDLOTS ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOIL |
| 400 72 2211 | NEBRASKA | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING NA |
| 400 72 2211 | NEBRASKA | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING SA |
| 400 71 2270 | NEBRASKA | DRAINING FEEDLOT RUNOFF KEYWORDS RUNOFF-CONTROL FEEDLOTS NEBRASKA WATER-POLLUTION GROU |
| 100 75 2280 | NEBRASKA | THE NITROGEN STATUS BENEATH BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA KEYWORDS FEEDLOT |
| 300 74 2331 | NEBRASKA | NUTRIENT AND ENERGY COMPOSITION OF BEEF CATTLE FEEDLOT WASTE FRACTIONS KEYWORDS NUTRI |
| 700 73 2385 | NEBRASKA | PHYSICAL PROPERTIES OF A COLO SILTY CLAY LOAM SOIL DURING TWO YEARS IRRIGATION WITH EFF |
| 100 73 2447 | NEBRASKA | SOIL WATER NITRATE BENEATH A BROAD BASIN TERRACED FEEDLOT KEYWORDS SOIL-WATER NITRATES |
| 400 73 2519 | NEBRASKA | KEEPING THE FEEDER IN BUSINESS KEYWORDS NEBRASKA FEEDLOTS REGULATION WATER-POLLUTION |
| 300 2571 | NEBRASKA | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 400 72 2573 | NEBRASKA | A LIVESTOCKMANS GUIDE TO POLLUTION LAWS KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT |
| 200 75 2608 | NEBRASKA | CONTROL COLLECTION AND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS REGULATION ENGINEERING DES |
| 200 75 2702 | NEBRASKA | AN ECONOMIC AND MANAGERIAL EVALUATION OF MANURE FLUMING AND LAND APPLICATION SYSTEMS A |
| 200 75 2709 | NEBRASKA | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA KEYWORDS AGRIC |
| 300 69 2797 | NEBRASKA | MANAGEMENT AND CONTROL OF BEEF FEEDLOT WASTE KEYWORDS FEEDLOTS CATTLE NEBRASKA REGULAT |
| 300 2571 | NEGLIGENCE | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 100 72 2764 | NETHERLANDS | THE REMOVAL OF ANIMAL EXCREMENTS FROM MASS-STOCK FARMS AS A WATER ECONOMY PROBLEM KEYW |
| 200 75 2716 | NETWORK-ANALYSIS-T | SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST DAIRY |
| 300 72 2087 | NEUTRALIZATION | DUST AND ODOR PROBLEMS OF THE FEEDLOT KEYWORDS ODOR DUST FEEDLOTS AIR-POLLUTION LEGA |
| 200 70 2398 | NEW-HAMPSHIRE | ROLE OF AGRICULTURE IN THE QUALITY OF THE NEW HAMPSHIRE ENVIRONMENT KEYWORDS AGRICULT |
| 200 70 2399 | NEW-JERSEY | REPORT FROM NEW JERSEY KEYWORDS NEW-JERSEY ENVIRONMENTAL-CONTROL WASTE-DISPOSAL POLLU |
| 300 68 2416 | NEW-JERSEY | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION KEYWORDS POULTRY FARM- |
| 100 73 1660 | NEW-MEXICO | FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAM |
| 200 74 2010 | NEW-YORK | AN ECONOMIC ANALYSIS OF POLICIES TO CONTROL NUTRIENT AND SOIL LOSSES FROM A SMALL WATER |
| 200 75 2598 | NEW-YORK | ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS I |
| 100 74 2288 | NEW-ZEALAND | AEROBIC TREATMENT OF FARM WASTES KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL ANAEROBI |
| 600 73 2366 | NEW-ZEALAND | BIO GAS DISPOSAL SYSTEM NOT ON KEYWORDS METHANE COSTS ANAEROBIC-DIGESTION EFFLUENT NE |
| 600 73 2552 | NEW-ZEALAND | MOST PIG WASTE DISPOSAL SYSTEMS SATISFACTORY KEYWORDS LAGOONS DESIGN WASTE-DISPOSAL PU |
| 100 72 2759 | NEW-ZEALAND | HIGH RISE POULTRY HOUSES KEYWORDS ECONOMICS ODOR HIGH-RISE-POULTRY-HOUSES NEW-ZEALAND |
| 100 72 2309 | NEW-ZEALAND | EFFLUENT SPRAY DISEASE RISK KEYWORDS HEALTH DISEASES SALMONELLA SPRAY-IRRIGATION CATT |
| 300 68 1625 | NITRATES | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 300 72 1628 | NITRATES | NEBRASKA ANIMAL WASTE RESEARCH KEYWORDS ANIMAL-WASTES RESEARCH-AND-DEVELOPMENT NEBRAS |
| 100 73 1639 | NITRATES | EFFECTS OF SURFACE IRRIGATION WITH DAIRY MANURE SLURRIES ON THE QUALITY OF GROUNDWATER |
| 100 73 1660 | NITRATES | FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAM |
| 700 71 1668 | NITRATES | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 700 71 1669 | NITRATES | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 700 71 1762 | NITRATES | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |
| 700 1767 | NITRATES | MANURE WASTE PONDING STUDY KEYWORDS GROUNDWATER-POLLUTION NITRATES HOLDING-PONDS MANU |
| 700 70 1779 | NITRATES | THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS KEYWORDS NITROGEN FEEDLOTS SOILS CAT |
| 300 66 1786 | NITRATES | NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWORDS NITRATES NITRITES POLLUTANTS WATER |
| 300 73 1787 | NITRATES | ESTABLISHING THE IMPACT OF AGRICULTURAL PRACTICES IN GROUNDWATER QUALITY KEYWORDS WAT |
| 600 74 1845 | NITRATES | ANIMAL WASTE AND NITRATE MOVEMENT THROUGH SOIL KEYWORDS ANIMAL-WASTES GROUNDWATER-POLL |
| 600 73 1848 | NITRATES | MODEL OF NITRATE PRODUCTION AND MOVEMENT IN MANURE DISPOSAL PLOTS KEYWORDS COMPUTER-M |
| 600 72 1875 | NITRATES | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 200 72 1880 | NITRATES | EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES |
| 400 72 1893 | NITRATES | LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD |
| 400 70 1896 | NITRATES | WATER QUALITY AND WASTE DISPOSAL IN MONTANA KEYWORDS WATER-QUALITY WASTE-DISPOSAL MONT |
| 400 70 1947 | NITRATES | LITTLE POLLUTION FROM THIS FEEDLOT KEYWORDS FEEDLOTS NEBRASKA ANALYSIS NITRATES GASES |
| 200 71 1962 | NITRATES | PROCEEDINGS OF CONFERENCES ON FARM ANIMAL WASTES NITRATES AND PHOSPHATES IN RURAL WISCO |
| 200 71 1965 | NITRATES | SOURCES AND FATE OF AVAILABLE NITROGEN IN RURAL ECOSYSTEMS KEYWORDS NITROGEN NITRATES |
| 200 74 2032 | NITRATES | EFFECT OF LIQUID SWINE WASTE APPLICATION ON SOIL CHEMICAL COMPOSITION KEYWORDS LIQUID |
| 200 74 2033 | NITRATES | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS [illegible] |
| 200 74 2034 | NITRATES | SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES KEYWORDS DAIRY-INDUSTRY SOIL |
| 300 73 2035 | NITRATES | DEMONSTRATION OF WASTE DISPOSAL SYSTEM KEYWORDS CATTLE HOGS ANIMAL-WASTES SHEEP LAGOO |
| 400 73 2051 | NITRATES | BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS KEYWORDS TERRACES FEEDLOTS EROSION GR |
| 700 73 2061 | NITRATES | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF KEYWORDS BIOLOGICAL-TREATMENT AGRICULTURAL-RUN |
| 600 74 [illegible] | NITRATES | TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES KEYWORDS SOIL-PROFILE |
| [illegible] 74 2082 | NITRATES | WASTE ACCUMULATION ON A SELECTED DAIRY CORRAL AND ITS EFFECT ON THE NITRATE AND SALT OF |
| 100 73 2119 | NITRATES | EFFECTS OF APPLICATION RATE ON DIRECT LAND DISPOSAL OF ANIMAL WASTES KEYWORDS EFFECTS |
| 100 74 2131 | NITRATES | THE EFFECT OF LARGE APPLICATIONS OF MANURE ON MOVEMENT OF NITRATE AND CARBON IN AN IRRI |
| 300 71 2133 | NITRATES | ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT-TECHNOLOGY AND ECONOMICS PHASE I KEYW |
| 200 65 [illegible] | NITRATES | WATER POLLUTION PREVENTION KEYWORDS WATER-POLLUTION GROUNDWATER LIVESTOCK POULTRY AGR |
| 600 69 2176 | NITRATES | THE EFFECT OF FARM WASTES ON THE POLLUTION OF NATURAL WATER KEYWORDS FARM-WASTES [illegible] |
| 200 66 2182 | NITRATES | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES A |
| 100 72 2197 | NITRATES | NITRATES IN SOIL AND GROUND WATER BENEATH IRRIGATED AND FERTILIZED CROPS KEYWORDS NIT |
| 100 75 [illegible] | NITRATES | CHEMICAL CHARACTERISTICS OF A FEEDLOT SOIL PROFILE KEYWORDS FEEDLOTS SOIL-PROFILES CH |
| [illegible] 74 [illegible] | NITRATES | ANIMAL WASTES AND FERTILIZERS AS POTENTIAL SOURCES OF NITRATE POLLUTION OF WATER [illegible] |

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| 400 | 71 | 2269 | NITRATES | MANURE ON MILLET KEYWORDS AMMONIA TOXICITY NITRATES MANURE MILLET APPLICATION-RATES |
| 700 | 71 | 2308 | NITRATES | NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA |
| 100 | 74 | 2337 | NITRATES | MANURE GETS REDISCOVERED KEYWORDS FEEDLOTS FERTILIZERS LIVESTOCK COSTS ENERGY NITRATE |
| 100 | 75 | 2352 | NITRATES | DAIRY CATTLE MANURE-ITS EFFECT ON RYE AND MILLET FORAGE YIELD AND QUALITY KEYWORDS DA |
| 700 | 74 | 2362 | NITRATES | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 100 | 70 | 2381 | NITRATES | COMPARISON OF INORGANIC NITROGEN CONTENTS OF UNDISTURBED CULTIVATED AND BARNYARD SOIL P |
| 100 | 71 | 2413 | NITRATES | SUBSURFACE DISTRIBUTION OF NITRATES BELOW COMMERCIAL CATTLE FEEDLOTS TEXAS HIGH PLAINS |
| 200 | 73 | 2442 | NITRATES | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES LI |
| 100 | 73 | 2447 | NITRATES | SOIL WATER NITRATE BENEATH A BROAD BASIN TERRACED FEEDLOT KEYWORDS SOIL-WATER NITRATES |
| 300 | 71 | 2451 | NITRATES | LIVESTOCK FEEDLOTS ARE POLLUTION SOURCE KEYWORDS FEEDLOTS WATER-POLLUTION MINNESOTA AI |
| 200 | 73 | 2529 | NITRATES | POTENTIAL OF RECYCLING SWINE WASTE KEYWORDS RECYCLING PERFORMANCE REFEEDING OXIDATION |
| 200 | 75 | 2616 | NITRATES | MILKING CENTER WASTE MANAGEMENT KEYWORDS DAIRY-INDUSTRY RECYCLING IRRIGATION EFFLUENT |
| 200 | 75 | 2660 | NITRATES | RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE ON GRAIN SORGHUM YIELDS KEYWORDS FERTILIZE |
| 200 | 75 | 2670 | NITRATES | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORDS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2671 | NITRATES | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 200 | 75 | 2673 | NITRATES | ANIMAL WASTE CONTRIBUTION TO NITRATE NITROGEN IN SOIL KEYWORDS LIQUID-WASTES DAIRY-IND |
| 200 | 75 | 2678 | NITRATES | OXIDATION NITRIFICATION AND DENITRIFICATION OF VEAL CALF MANURE KEYWORDS FERMENTATION |
| 200 | 75 | 2754 | NITRATES | POLLUTION ABATEMENT OF POULTRY MANURE BY MAXI-MIXING METHOD KEYWORDS POULTRY COSTS WAS |
| 600 | | 2777 | NITRATES | GROUND WATER CONTAMINATION BY DISSOLVED NITRATE KEYWORDS NITRATES FERTILIZERS GEOCHEMI |
| 400 | 74 | 1921 | NITRATE-CONCENTRAT | ABANDONED FEEDLOTS CAN POLLUTE MORE THAN ACTIVE ONES KEYWORDS FEEDLOTS NITROGEN ABANDO |
| 200 | 75 | 2731 | NITRIENTS | OXIDATION DITCHES FOR LIVESTOCK WASTES KEYWORDS LIVESTOCK AEROBIC-TREATMENT DESIGN-CR |
| 100 | 73 | 1673 | NITRIFICATION | TROLT METABOLISM CHARACTERISTICS AND THE RATIONAL DESIGN OF NITRIFICATION FACILITIES FO |
| 300 | | 1829 | NITRIFICATION | THE TREATMENT OF MANURE IN OXIDATION DITCHES KEYWORDS WASTE-TREATMENT MANURE OXIDATION |
| 300 | 73 | 1873 | NITRIFICATION | DEVELOPMENT AND DEMONSTRATION OF NUTRIENT REMOVAL FROM ANIMAL WASTES KEYWORDS NITROGE |
| 100 | 73 | 1905 | NITRIFICATION | AEROBIC TREATMENT OF PIGGERY WASTE KEYWORDS AEROBIC-TREATMENT SWINE EFFLUENTS SUSPEND |
| 400 | 70 | 1947 | NITRIFICATION | LITTLE POLLUTION FROM THIS FEEDLOT KEYWORDS FEEDLOTS NEBRASKA ANALYSIS NITRATES GASES |
| 200 | 74 | 2025 | NITRIFICATION | WASTE TREATMENT WITH A PROTEIN BONUS KEYWORDS AEROBIC-TREATMENT PROTEINS NITRIFICATIO |
| 600 | 69 | 2179 | NITRIFICATION | THE EFFECT OF FARM WASTES ON THE POLLUTION OF NATURAL WATER KEYWORDS FARM-WASTES WATE |
| 100 | 74 | 2242 | NITRIFICATION | NITROGEN LOSS FROM MANURE AS INFLUENCED BY MOISTURE AND TEMPERATURE KEYWORDS NITROGEN |
| 300 | 74 | 2255 | NITRIFICATION | ANIMAL WASTES AND FERTILIZERS AS POTENTIAL SOURCES OF NITRATE POLLUTION OF WATER KEYWO |
| 100 | 75 | 2272 | NITRIFICATION | MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE KEYWORDS POULTR |
| 100 | 75 | 2293 | NITRIFICATION | NITRIFICATION IN SOILS INCUBATED WITH PIG SLURRY KEYWORDS NITRIFICATION SOILS SLURRIE |
| 100 | 72 | 2357 | NITRIFICATION | MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES KEYWORDS MICROBIAL |
| 200 | 72 | 2361 | NITRIFICATION | THE FATE OF NITROGEN AND PHOSPHORUS IN AN OXIDATION DITCH TREATING SWINE WASTES KEYWOR |
| 700 | 67 | 2363 | NITRIFICATION | ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S |
| 200 | 75 | 2678 | NITRIFICATION | OXIDATION NITRIFICATION AND DENITRIFICATION OF VEAL CALF MANURE KEYWORDS FERMENTATION |
| 100 | 75 | 2813 | NITRIFICATION | CORN RESPONSE AND SOIL NITROGEN TRANSFORMATIONS FOLLOWING VARIED APPLICATION OF POULTRY |
| 100 | 70 | 2786 | NITRIFICATION-DENI | TREATMENT AND DISPOSAL OF ANIMAL WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL ANIMA |
| 100 | 75 | 2293 | NITRIFYING-BACTERI | NITRIFICATION IN SOILS INCUBATED WITH PIG SLURRY KEYWORDS NITRIFICATION SOILS SLURRIE |
| 300 | 68 | 1625 | NITRITES | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER DITC |
| 700 | 71 | 1668 | NITRITES | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 700 | 70 | 1779 | NITRITES | THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS KEYWORDS NITROGEN FEEDLOTS SOILS CAT |
| 300 | 73 | 1785 | NITRITES | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 300 | 64 | 1786 | NITRITES | NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWORDS NITRATES NITRITES POLLUTANTS WATER |
| 200 | 64 | 2182 | NITRITES | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N |
| 100 | 75 | 2272 | NITRITES | MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE KEYWORDS POULTR |
| 700 | 71 | 2308 | NITRITES | NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA |
| 100 | 70 | 2381 | NITRITES | COMPARISON OF INORGANIC NITROGEN CONTENTS OF UNDISTURBED CULTIVATED AND BARNYARD SOIL P |
| 200 | 75 | 2671 | NITRITES | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 200 | 75 | 2678 | NITRITES | OXIDATION NITRIFICATION AND DENITRIFICATION OF VEAL CALF MANURE KEYWORDS FERMENTATION |
| 100 | 75 | 2790 | NITRITES | TOXICITY OF NITRITE TO CHANNEL CATFISH KEYWORDS CATFISHES NITRITES AMMONIA TOXICITY |
| 200 | 72 | 1645 | NITROGEN | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 200 | 72 | 1645 | NITROGEN | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 100 | 73 | 1653 | NITROGEN | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 73 | 1654 | NITROGEN | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 74 | 1655 | NITROGEN | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 72 | 1657 | NITROGEN | MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT SLURRY KEYWORDS NITROGEN FERTIL |
| 100 | 69 | 1659 | NITROGEN | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 700 | 71 | 1668 | NITROGEN | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 700 | 70 | 1680 | NITROGEN | EFFECT OF FEEDLOT LAGOON WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED NON |
| 600 | 74 | 1686 | NITROGEN | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 600 | 74 | 1712 | NITROGEN | MOVEMENT OF MANURIAL NITROGEN IN COOL HUMID CLIMATES KEYWORDS MODEL-STUDIES NITROGEN M |
| 300 | 73 | 1745 | NITROGEN | GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS KEYWORDS FEEDLOTS MANURE CATTLE |
| 600 | 74 | 1748 | NITROGEN | FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS FLOCCULATION CATTLE FL |
| 100 | 72 | 1755 | NITROGEN | AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES KEYWORDS SAMPLING SOILS NI |
| 100 | 73 | 1775 | NITROGEN | DAIRY CATTLE MANURE LIQUID SOLIDS SEPARATION WITH A SCREW PRESS KEYWORDS [illegible] |
| 200 | 74 | 1777 | NITROGEN | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS [illegible] |
| 700 | 72 | 1779 | NITROGEN | THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS KEYWORDS NITROGEN FEEDLOTS SOILS CAT |
| 300 | 74 | 1783 | NITROGEN | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY FLOCCULATION [illegible] |
| 400 | 73 | 1787 | NITROGEN | ESTABLISHING THE IMPACT OF AGRICULTURAL PRACTICES ON GROUNDWATER QUALITY KEYWORDS [illegible] |
| 100 | 73 | 1802 | NITROGEN | EFFECTS OF CONTINUOUS [illegible] |
| 600 | 73 | 1813 | NITROGEN | EXPERIENCE WITH A SPRAY RUNOFF SYSTEM FOR TREATING BEEF CATTLE FEEDLOT RUNOFF KEYWORDS |
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200 64 2182  NITROGEN          NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS  NITRATES NITRITES N
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300 74 2217  NITROGEN          COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING
100 73 2226  NITROGEN          INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH LEPOMI
400 72 2231  NITROGEN          MANURE CAN CUT YOUR FERTILIZER BILL  KEYWORDS  FERTILIZERS  COSTS NUTRIENTS NITROGEN PH
700 63 2233  NITROGEN          CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE  KEYWORDS  FARM-WASTES HOGS ANAE
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600 73 2245  NITROGEN          GROUNDWATER QUALITY BENEATH A MANURE DISPOSAL AREA KEYWORDS  WASTE-DISPOSAL NUTRIENTS N
300 74 2248  NITROGEN          IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR
100 75 2265  NITROGEN          SPRAY IRRIGATION OF DAIRY CATTLE MANURE EFFLUENT FOR MAXIMIZING CROP PRODUCTION  KEYWOR
400 73 2266  NITROGEN          VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY  KEYWORDS  FEEDS POULTRY ENERGY
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100 75 2280  NITROGEN          THE NITROGEN STATUS BENEATH BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA  KEYWORDS  FEEDLOT
300 72 2292  NITROGEN          MANURE HOLDING PONDS FOUND SELFSEALING  KEYWORDS  WASTE-STORAGE WATER-POLLUTION POULTRY
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600 72 2302  NITROGEN          WHY POULTRY MANURE VARIES AS FERTILIZER  KEYWORDS  POULTRY  FERTILIZERS NITROGEN PHOSPH
700 71 2307  NITROGEN          FECAL COLIFORM POLLUTION IN AN AGRICULTURAL ENVIRONMENT KEYWORDS  WATER-POLLUTION AGRIC
700 72 2315  NITROGEN          THE STRATIFICATION OF AN ANAEROBIC DAIRY MANURE LAGOON KEYWORDS  DAIRY-INDUSTRY STRATIF
100 74 2340  NITROGEN          RESULTS FROM EXPERIMENTS MEASURING THE EFFECTS OF LARGE AMOUNTS OF FERTILIZER AND OF FA
100 75 2352  NITROGEN          DAIRY CATTLE MANURE-ITS EFFECT ON RYE AND MILLET FORAGE YIELD AND QUALITY  KEYWORDS  DA
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400 72 2386  NITROGEN          SWINE MANURE LAND APPLICATION RATES  KEYWORDS  WASTE-DISPOSAL NITROGEN INDIANA WATER-PO
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300 68 2414  NITROGEN          POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION  KEYWORDS  POULTRY FARM-
100 65 2423  NITROGEN          VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL  KEYWORDS NUTRIENTS NITROGEN PHOSPHORUS
200 73 2443  NITROGEN          REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF CLIPE
700 72 2448  NITROGEN          TRANSFORMATION MOVEMENT AND DISPOSAL OF NITROGEN FROM ANIMAL MANURE WASTES APPLIED TO S
100 69 2450  NITROGEN          ANAEROBIC DIGESTION OF HOG WASTES  KEYWORDS  ANAEROBIC-DIGESTION DESIGN HOGS TEMPERATUR
100 74 2452  NITROGEN          RECYCLING ANIMAL WASTES  KEYWORDS  RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN
700 70 2455  NITROGEN          CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE  KEYWOR
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600 75 2544  NITROGEN          NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT  KEYWORDS  TECHNOLOGY NUTRIENTS NITROG
100 71 2551  NITROGEN          COMPARATIVE EVALUATION OF SOME TECHNIQUES USED IN DETERMINATIONS OF NITROGEN AND ENERGY
700 72 2564  NITROGEN          RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFF
700 73 2577  NITROGEN          RATE AND EXTENT OF NITROGEN AND PHOSPHORUS MOVEMENT THROUGH [illegible] DEPOSITED SOILS T
100 63 2581  NITROGEN          ANAEROBIC DIGESTION OF HOG WASTES  KEYWORDS  ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA
200 75 2598  NITROGEN          ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS I
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200 75 2672  NITROGEN          NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS  KEYWORDS  WINTER AGRICUL
200 75 2675  NITROGEN          ANIMAL WASTE CONTRIBUTION TO NITRATE NITROGEN IN SOIL KEYWORDS  LIQUID-WASTES DAIRY-IND
200 75 2677  NITROGEN          NITROGEN REMOVAL AND RECOVERY FROM POULTRY WASTEWATER BY ION EXCHANGE  KEYWORDS  POULTR
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200 75 2726  NITROGEN          CONSERVATION OF NITROGEN IN DAIRY MANURE DURING COMPOSTING  KEYWORDS  NITROGEN DAIRY-IN
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300    2571  NOISE              LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS  LEGAL-ASPECTS FEEDLOTS NE
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100 73 1653  NORTHERN-IRELAND   THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU
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600 71 1723  NORTH-CENTRAL-STAT SWINE SYSTEMS FOR IOWA AND NORTH CENTRAL STATES  KEYWORDS SWINE WASTE-MANAGEMENT IOWA E
600 71 2778  NORTH-CENTRAL-US   A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT
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400 72 2573  NORTH-DAKOTA       A LIVESTOCKMANS GUIDE TO POLLUTION LAWS  KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT
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400 74 2203  NUISANCE-LAWSUITS  NUISANCE LAWSUITS-NEIGHBOR VS NEIGHBOR  KEYWORDS  LEGAL-ASPECTS WASTE-TREATMENT WASTE-D
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200 69 1840  NUTRIENTS          PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT KEYWORDS  DRIED-POULTRY-WASTE R
300 73 1856  NUTRIENTS          RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES  KEYWORDS  RUMINAN
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700 71 1864  NUTRIENTS          KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR
300 71 1882  NUTRIENTS          RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE  ROLE OF LAND AND SOIL
400 74 1887  NUTRIENTS          ALL OF A SUDDEN MANURE DOESNT SMELL SO BAD ANYMORE  KEYWORDS  ANIMAL-WASTES FERTILIZERS
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300 73 1915  NUTRIENTS          METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM  AGRICULTURAL NONPOINT SOURC
100 74 1956  NUTRIENTS          DISPOSAL OF EFFLUENT FROM A BEEF CATTLE FEEDLOT RUNOFF CONTROL HOLDING POND  KEYWORDS
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200 69 1983  NUTRIENTS          USE OF POULTRY MANURE AND LITTER IN CROP PRODUCTION  KEYWORDS  CROP-PRODUCTION FERTILIZ
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| 600 | 68 | 1862 | OXYGEN-TRANSFER | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 700 | 73 | 2379 | OXYGEN-TRANSFER | OXYGEN TRANSFER RELATIONSHIPS IN A POULTRY WASTE MIXED LIQUOR KEYWORDS WASTE-TREATMEN |
| 200 | 75 | 2717 | OXYGEN-TRANSFER | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 100 | 72 | 1621 | OZONATION | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 200 | 74 | 2039 | OZONE | POSSIBLE WAYS OF ABATING THE NUISANCE OF SMELL CAUSED BY LIVESTOCK AND POULTRY FARMS K |
| 300 | 74 | 1677 | PACIFIC-NORTHWEST | ANAEROBIC AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES KEYWORDS AEROBIC-TREATMENT A |
| 200 | 75 | 2790 | PACIFIC-NORTHWEST- | ON-THE-FARM DETERMINATION OF ANIMAL WASTE DISPOSAL RATES FOR CROP PRODUCTION KEYWORDS |
| 200 | 66 | 2566 | PACKING-HOUSE-WAST | NEWER ASPECTS I TREATMENT OF PACKING HOUSE AND FEEDLOT WASTES KEYWORDS WASTE-TREATME |
| 600 | 74 | 1809 | PADDLEWHEELS | MANURE REFEEDING CUTS ODOR SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN KEYWORDS ELECTRIC |
| 600 | 68 | 1862 | PARAMETERS | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 300 | 68 | 2220 | PARAMETERS-MEASURE | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 200 | 73 | 2278 | PARASITES | CONVERTING SWINE WASTE INTO A NUTRIENT SOURCE FOR SWINE KEYWORDS RECYCLING FEEDS NUTRI |

# KEYWORD INDEX

| | | | | |
|---|---|---|---|---|
| 300 | 75 | 2545 | PARASITES | INTEGRATED FLY CONTROL ON POULTRY RANCHES KEYWORDS PREDATORS SCAVENGERS POULTRY [illegible] |
| 200 | 75 | 2589 | PARASITES | PATHOGENIC MICROORGANISMS IN THE ENVIRONMENT KEYWORDS PATHOGENIC-BACTERIA ANIMAL-WASTE |
| 200 | 75 | 2645 | PARASITISM | NUTRITIONAL PATHOLOGICAL AND PARASITOLOGICAL EFFECTS OF FEEDING FEEDLOT WASTE TO BEEF [illegible] |
| 100 | 75 | 2456 | PARASITOIDS | WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE KEY |
| 200 | 74 | 2136 | PARTIALLY-COVERED- | ANIMAL WASTE SYSTEMS KEYWORDS FEEDLOTS CONFINEMENT-PENS MICHIGAN WASTE-STORAGE WASTE- |
| 100 | 74 | 2515 | PARTICLE-DENSITY | PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE [illegible] |
| 100 | 74 | 2097 | PARTICLE-SIZE | SIZE DISTRIBUTION AND NUTRITIONAL VALUE OF SWINE MANURE SEPARATES KEYWORDS NUTRIENTS |
| 100 | 72 | 2197 | PARTICLE-SIZE | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
| 100 | 74 | 2253 | PARTICULATES | ELEMENTAL COMPOSITION OF PARTICULATES NEAR A BEEF CATTLE FEEDLOT KEYWORDS DUSTS [illegible] |
| 200 | 72 | 1645 | PASTEURIZATION | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 100 | 72 | 1667 | PASTEURIZATION | THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES KEYWORDS [illegible] |
| 400 | 72 | 1842 | PASTEURIZATION | N.J PREVIEWS FIRST COMMERCIAL MANURE SYSTEM KEYWORDS AEROBIC-TREATMENT LIQUID-WASTE-TRE |
| 100 | 71 | 2424 | PASTURES | VOLATILIZATION OF NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS KEYWORDS [illegible] |
| 700 | 74 | 2362 | PASTURE-MANAGEMENT | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 100 | 73 | 1653 | PASTURE-RESPONSE | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 73 | 1654 | PASTURE-RESPONSE | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 74 | 1655 | PASTURE-RESPONSE | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 75 | 2244 | PASTURIZATION | EFFECT OF PROCESSING METHOD ON PASTURIZATION AND NITROGEN COMPONENTS OF BROILER LITTER |
| 200 | 68 | 1643 | PATHOGENIC-BACTERI | MICROBIOLOGICAL ASPECTS OF POULTRY WASTES KEYWORDS [illegible] |
| 100 | 73 | 1685 | PATHOGENIC-BACTERI | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 700 | 69 | 1863 | PATHOGENIC-BACTERI | METHODS FOR RAPID IDENTIFICATION AND ENUMERATION OF STREPTOCOCCUS BOVIS FROM WATER KEY |
| 200 | 74 | 2008 | PATHOGENIC-BACTERI | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 200 | 63 | 2162 | PATHOGENIC-BACTERI | WATER POLLUTION PREVENTION KEYWORDS WATER-POLLUTION GROUNDWATER LIVESTOCK POULTRY [illegible] |
| 400 | 72 | 2304 | PATHOGENIC-BACTERI | DATA NEEDED ON SAFETY OF RECYCLING WASTE KEYWORDS RECYCLING PATHOGENIC-BACTERIA [illegible] |
| 300 | 73 | 2384 | PATHOGENIC-BACTERI | SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS |
| 300 | 73 | 2407 | PATHOGENIC-BACTERI | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS [illegible] |
| 100 | 75 | 2419 | PATHOGENIC-BACTERI | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS [illegible] |
| 400 | 67 | 2420 | PATHOGENIC-BACTERI | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS [illegible] |
| 200 | 75 | 2589 | PATHOGENIC-BACTERI | PATHOGENIC MICROORGANISMS IN THE ENVIRONMENT KEYWORDS PATHOGENIC-BACTERIA ANIMAL-WASTE |
| 200 | 75 | 2684 | PATHOGENIC-BACTERI | SWINE WASTE LAGOONS AS POTENTIAL DISEASE RESERVOIRS KEYWORDS LAGOONS DISEASES [illegible] |
| 200 | 64 | 1703 | PATHOGENS | HEALTH ASPECTS OF POULTRY WASTE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL PUBLIC-HEALTH |
| 200 | 74 | 2020 | PATHOGENS | INFLUENCE OF INGESTION OF ANAEROBIC LAGOON EFFLUENT ON GROWING SWINE KEYWORDS [illegible] |
| 100 | 75 | 2365 | PATHOGENS | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS [illegible] |
| 300 | 74 | 2527 | PATHOGENS | FERMENTATION OF ENSILED BROILER LITTER KEYWORDS FERMENTATION LITTER PATHOGENS [illegible] |
| 200 | 75 | 2666 | PATHOGENS | THE EFFICIENCY OF USING SLUDGE FROM PIG GROWING COMPLEXES AS ORGANIC FERTILIZER KEYWOR |
| 200 | 75 | 2676 | PATHOGENS | NUTRIENT CHARACTERISTICS OF WASTES FROM DEEP PITS AND ANAEROBIC LAGOONS KEYWORDS LAGO |
| 200 | 75 | 2730 | PATHOGENS | INVESTIGATIONS ON THE PROCEDURE AND THE TURN-OVER OF ORGANIC MATTER AT HOT FERMENTATION |
| 200 | 72 | 2783 | PATHOGENS | MANURE HANDLING CAPACITY OF SOILS FROM A MICROBIOLOGICAL POINT OF VIEW KEYWORDS SOILS |
| 200 | 75 | 2679 | PATHOGEN | BACTERIAL ANALYSIS AND LAND DISPOSAL OF FARM WASTE LAGOON WATERS KEYWORDS LAGOONS [illegible] |
| 200 | 75 | 2645 | PATHOLOGY | NUTRITIONAL PATHOLOGICAL AND PARASITOLOGICAL EFFECTS OF FEEDING FEEDLOT WASTE TO BEEF [illegible] |
| 700 | 74 | 2362 | PATH-OF-POLLUTANTS | NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS KEYWORDS FARM-WASTES WATER-POLL |
| 300 | 74 | 2576 | PATH-OF-POLLUTANTS | POLLUTED GROUNDWATER-A REVIEW OF THE SIGNIFICANT LITERATURE KEYWORDS GROUNDWATER-POLL |
| 200 | 74 | 1989 | PAUNCH-CONTENT | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS [illegible] |
| 300 | 74 | 2173 | PAUNCH-CONTENT | PAUNCH CONTENT BLOODMEAL MIXTURE AS PROTEIN SUPPLEMENT IN FEEDLOT RATIONS KEYWORDS [illegible] |
| 300 | 74 | 1914 | PAUNCH-MANURE | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE [illegible] |
| 400 | 75 | 2499 | PAUNCH-MANURE | PAUNCH FEEDING NOW PROFITABLE KEYWORDS ECONOMICS CATTLE [illegible] |
| 600 | 71 | 2531 | PAVED-LOTS | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEEDLOTS DESIGN-CRITERIA MONTANA [illegible] |
| 400 | 73 | 1740 | PAVED-YARDS | RUNOFF CONTROL SYSTEMS FOR CONCRETE DAIRY CATTLE YARDS KEYWORDS CATTLE DAIRY-INDUSTRY |
| 400 | 75 | 2056 | PEAT | MILK PLUS MANURE-HIGHER DAIRY PROFITS KEYWORDS SEPARATION-TECHNIQUES [illegible] |
| 700 | 69 | 2225 | PEAT-MOSS | AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON THE AERATION AND [illegible] |
| 400 | 60 | 2534 | PELLETING | MANURE DISPOSAL POSES PROBLEM KEYWORDS POULTRY WASTE-DISPOSAL [illegible] |
| 400 | 74 | 1769 | PENNSYLVANIA | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING [illegible] |
| 100 | 75 | 2265 | PENNSYLVANIA | SPRAY IRRIGATION OF DAIRY CATTLE MANURE EFFLUENT FOR MAXIMIZING CROP PRODUCTION KEYWOR |
| 300 | 74 | 2556 | PERCOLATING-WATER | WATER QUALITY AND SOIL EROSION FROM SURFACE APPLICATION OF TREATED LIQUID SWINE WASTE |
| 700 | 66 | 1679 | PERCOLATION | TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS [illegible] |
| 700 | 69 | 1706 | PERCOLATION | SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT KEYWORDS SOILS [illegible] |
| 300 | | 1767 | PERCOLATION | MANURE WASTE PONDING STUDY KEYWORDS GROUNDWATER-POLLUTION NITRATES [illegible] |
| 300 | 74 | 1783 | PERCOLATION | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE [illegible] |
| 100 | 71 | 1936 | PERCOLATION | TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM MEASUREMENT OF DIFFUSIVITY IN CATTLE |
| 600 | 74 | 2081 | PERCOLATION | TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES KEYWORDS SOIL-PROFILES |
| 200 | 63 | 2162 | PERCOLATION | WATER POLLUTION PREVENTION KEYWORDS WATER-POLLUTION GROUNDWATER LIVESTOCK POULTRY [illegible] |
| 700 | 70 | 2455 | PERCOLATION | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE KEYWOR |
| 100 | 73 | 2812 | PERCOLATION | PHOSPHORUS IN PERCOLATES FROM MANURED LYSIMETERS KEYWORDS PHOSPHORUS PERCOLATION [illegible] |
| 700 | 67 | 1877 | PERFORATED-FLOORS | AN EXPERIMENTAL ANALYSES OF STRAIN AND DEFLECTION IN [illegible] PANELS FOR FLOOR SYSTEMS |
| 400 | 72 | 2299 | PERFORMANCES | UPW RECYCLING FACTS UPDATED KEYWORDS RECYCLING COSTS PERFORMANCES [illegible] |
| 600 | 73 | 1616 | PERFORMANCE | WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS KEYWORDS CATTLE CONFINEMENT-PENS [illegible] |
| 400 | 73 | 1618 | PERFORMANCE | THEY BEAT THE HIGH COST OF PROTEIN WITH PLS KEYWORDS COSTS RATIONS FEEDS POULTRY [illegible] |
| 300 | 73 | 1620 | PERFORMANCE | PROTOTYPE OF A BROILER CAGE SYSTEM KEYWORDS BROILERS PERFORMANCE CAGE-SYSTEM [illegible] |
| 400 | 73 | 1632 | PERFORMANCE | FEEDING STEERS DPW KEYWORDS FEEDS POULTRY CATTLE PROTEINS PERFORMANCE [illegible] |
| 200 | 72 | 1645 | PERFORMANCE | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 700 | 65 | 1666 | PERFORMANCE | PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH KEYWORDS OXIDATION-DITCH PERFORMANCE |
| 600 | 74 | 1671 | PERFORMANCE | PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS KEYWORDS FEEDLOTS [illegible] |
| 600 | 67 | 1683 | PERFORMANCE | PERFORMANCE OF EXPERIMENTAL CLOSE-CONFINEMENT CALF CATTLE FEEDING SYSTEMS KEYWORDS |
| 600 | 71 | 1722 | PERFORMANCE | WASTE MANAGEMENT SYSTEMS FOR ROOFED BEEF CONFINEMENT FACILITIES KEYWORDS WASTE-MANAGE |
| 600 | 71 | 1726 | PERFORMANCE | EFFECT OF HOUSED CONFINEMENT ON ANIMAL PERFORMANCE KEYWORDS CONFINEMENT-PENS CATTLE [illegible] |
| 100 | 73 | 1747 | PERFORMANCE | FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS KEYWORDS DIETS POULTRY PROTEINS |
| 700 | 71 | 1766 | PERFORMANCE | WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE KEY |
| 300 | | 1792 | PERFORMANCE | SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF |
| 600 | 73 | 1803 | PERFORMANCE | FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE [illegible] |
| 200 | 69 | 1824 | PERFORMANCE | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
| 400 | 72 | 1836 | PERFORMANCE | FEEDING POULTRY MANURE TO ANIMALS KEYWORDS FEEDS EXCRETA [illegible] |
| 200 | 69 | 1840 | PERFORMANCE | PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT KEYWORDS DRIED-POULTRY-WASTE [illegible] |
| 300 | 73 | 1849 | PERFORMANCE | THE USE OF FORMALDEHYDE FLAKES AS AN ANTIMICROBIAL AGENT IN BUILT UP POULTRY LITTER [illegible] |
| 400 | 74 | 1861 | PERFORMANCE | INCLUSION OF DRIED POULTRY WASTE AS A FEED INGREDIENT IN CATFISH RATIONS KEYWORDS CAT |
| 600 | 68 | 1862 | PERFORMANCE | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED [illegible] |
| 200 | 74 | 1870 | PERFORMANCE | EVALUATION OF POULTRY MANURE AS A FEED INGREDIENT KEYWORDS POULTRY EXCRETA DRIED-POULT |
| 600 | 72 | 1886 | PERFORMANCE | SLOTTED FLOOR COLD CONFINEMENT BEEF CATTLE HOUSING KEYWORDS CATTLE DESIGN PERFORMANCE |
| 400 | 74 | 1906 | PERFORMANCE | PROCESSED MANURE SEEN AS PROTEIN OF FUTURE KEYWORDS CATTLE RECYCLING [illegible] |
| 600 | 74 | 1916 | PERFORMANCE | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY [illegible] |
| 400 | 74 | 1917 | PERFORMANCE | DO FLUMES REALLY WORK KEYWORDS FLUMES PERFORMANCE [illegible] |
| 400 | 72 | 1938 | PERFORMANCE | SAGEBRUSH FOR ODOR CONTROL-IN THE FEED OR THE MANURE KEYWORDS SAGEBRUSH FEEDS [illegible] |
| 400 | 72 | 1943 | PERFORMANCE | CLEANEST FEEDLOT IN KANSAS KEYWORDS KANSAS FEEDLOTS AGRICULTURAL-RUNOFF LAGOONS COSTS |
| 300 | 68 | 1948 | PERFORMANCE | THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF [illegible] |
| 100 | 74 | 1950 | PERFORMANCE | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORDS |
| 600 | 72 | 1954 | PERFORMANCE | EXPERIENCES WITH OXIDATION DITCHES IN A PULLET GROWING HOUSE KEYWORDS POULTRY DESIGN [illegible] |
| 400 | 74 | 1955 | PERFORMANCE | FEEDING PELLETED DRIED POULTRY LITTER TO HOLSTEIN STEERS KEYWORDS FEEDS PERFORMANCE [illegible] |
| 100 | 72 | 1960 | PERFORMANCE | COMPARISON OF SELECTED ENVIRONMENTAL CONDITIONS AND BEEF CATTLE PERFORMANCE IN FALL FOR |
| 200 | 71 | 1978 | PERFORMANCE | LARGE COMMERCIAL FEEDLOTS HOW WASTES ARE HANDLED IN THE WEST KEYWORDS FEEDLOTS [illegible] |
| 200 | 74 | 1989 | PERFORMANCE | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS [illegible] |
| 600 | 72 | 1992 | PERFORMANCE | EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM KEYWORDS CLIMATOLOGY [illegible] |

# KEYWORD INDEX

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|---|---|---|---|---|
| 200 | 74 | 2018 | PERFORMANCE | BEEF FEEDLOT WASTE IN RATIONS FOR BEEF CATTLE KEYWORDS CATTLE DIETS PERFORMANCE REFEED |
| 200 | 74 | 2022 | PERFORMANCE | BEEF OXIDATION DITCH SETTLED SOLIDS FED TO STEERS KEYWORDS FEEDS CATTLE SOLID-WASTES P |
| 400 | 75 | 2038 | PERFORMANCE | POULTRY WASTE FOR CATFISH KEYWORDS CATFISHES DIETS PERFORMANCE PROTEINS POULTRY-WASTE |
| 400 | 75 | 2040 | PERFORMANCE | PROCESSED EXCRETA POTENTIALLY NUTRITIONAL KEYWORDS CATTLE FEEDS PROTEINS RECYCLING PE |
| 400 | 74 | 2048 | PERFORMANCE | CONVENTIONAL CONFINEMENT OF FLUME KEYWORDS CONFINEMENT-PENS FLUMES COSTS PERFORMANCE |
| 300 | 73 | 2053 | PERFORMANCE | SWINE WASTE AS NUTRIENT SOURCE FOR FINISHING PIGS KEYWORDS FEEDS NUTRIENTS PERFORMANC |
| 400 | 73 | 2058 | PERFORMANCE | POULTRY WASTES STUDIED FOR USE IN LIVESTOCK FEED KEYWORDS FEEDS LIVESTOCK PERFORMANCE |
| 400 | 74 | 2065 | PERFORMANCE | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORDS IDAHO RECYCLIN |
| 100 | 74 | 2069 | PERFORMANCE | WINTER OPERATION OF A MODIFIED OPEN FRONT FINISHING HOUSE FOR SWINE KEYWORDS WINTER O |
| 400 | 73 | 2103 | PERFORMANCE | SLAB VS SLAT-AN EXPERT S OPINION KEYWORDS CONFINEMENT-PENS WASTE-DISPOSAL DESIGN ARIZ |
| 300 | 74 | 2118 | PERFORMANCE | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 200 | 63 | 2157 | PERFORMANCE | INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL KEYWORDS LAGOONS POULTRY WASTE-DISPOSAL OD |
| 600 | 69 | 2175 | PERFORMANCE | THE DESIGN AND OPERATION OF AN OPEN FRONT SLOTTED FLOOR BEEF CONFINEMENT BUILDING KEYW |
| 400 | 74 | 2202 | PERFORMANCE | NO PEN CLEANING COSTS KEYWORDS CONFINEMENT-PENS CATTLE KANSAS WASTE-DISPOSAL LAGOONS |
| 300 | 74 | 2217 | PERFORMANCE | COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING |
| 400 | 75 | 2251 | PERFORMANCE | FERTILIZER FEED VALUE OF SWINE WASTES DETAILED KEYWORDS RECYCLING FERTILIZERS FEEDS SW |
| 400 | 73 | 2266 | PERFORMANCE | VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY KEYWORDS FEEDS POULTRY ENERGY |
| 300 | 65 | 2267 | PERFORMANCE | OBSERVATIONS ON THE NUTRITIVE VALUE OF CHICKEN MANURE FOR CATTLE KEYWORDS FEEDS NUTRI |
| 400 | 71 | 2274 | PERFORMANCE | FEEDING WASTES KEYWORDS FEEDS NUTRIENTS PERFORMANCE DRIED-SWINE-FECES DEHYDRATED-POUL |
| 400 | 73 | 2287 | PERFORMANCE | DIGESTIBILITY OF PROCESSED FEEDLOT MANURE KEYWORDS FEEDS CATTLE SHEEP PROTEINS PERFO |
| 400 | 72 | 2305 | PERFORMANCE | PROCESSED POULTRY MANURE AS A FEEDSTUFF KEYWORDS POULTRY PERFORMANCE PHOSPHORUS AMIN |
| 400 | 75 | 2350 | PERFORMANCE | CATFISH ON DPW KEYWORDS CATFISHES DIETS PERFORMANCE TASTE COSTS DRIED-POULTRY-WASTE |
| 300 | 72 | 2367 | PERFORMANCE | A COMPARISON OF FIVE HOUSING SYSTEMS FOR FEEDLOT CATTLE KEYWORDS FEEDLOTS CONFINEMENT- |
| 300 | 72 | 2368 | PERFORMANCE | FINISHING YEARLINGS IN INSULATED HOUSING EQUIPPED WITH AN OXIDATION DITCH WASTE DISPOSA |
| 300 | 72 | 2369 | PERFORMANCE | COMPARISON OF HOUSING SYSTEMS FOR FEEDLOT CATTLE IN NORTHERN CLIMATES KEYWORDS PERFOR |
| 300 | 72 | 2370 | PERFORMANCE | COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS |
| 300 | 72 | 2372 | PERFORMANCE | INFLUENCE OF AN ANTIBIOTIC ON THE PERFORMANCE OF YEARLING HOLSTEIN STEERS KEYWORDS AN |
| 300 | 72 | 2374 | PERFORMANCE | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 100 | 75 | 2427 | PERFORMANCE | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 200 | 74 | 2464 | PERFORMANCE | OUR DEEP PIT SYSTEM KEYWORDS CONFINEMENT-PENS COSTS CATTLE LAGOONS WATER-POLLUTION-CO |
| 200 | 74 | 2465 | PERFORMANCE | NEW FLUSH FLUME SYSTEM WITH DEEP LAGOON KEYWORDS LAGOONS ODOR FEEDLOTS CONFINEMENT-P |
| 400 | 73 | 2504 | PERFORMANCE | STRIP MINE FEEDLOTS KEYWORDS STRIP-MINES FEEDLOTS CATTLE PERFORMANCE RUNOFF OHIO WAS |
| 100 | 72 | 2509 | PERFORMANCE | DEHYDRATED POULTRY WASTE IN POULTRY RATIONS KEYWORDS PERFORMANCE HEALTH ECONOMICS ODOR |
| 400 | 75 | 2512 | PERFORMANCE | INFLUENCE OF FEEDING DEHYDRATED POULTRY WASTE ON BROILER GROWTH AND MEAT FLAVOR AND COM |
| 200 | 73 | 2529 | PERFORMANCE | POTENTIAL OF RECYCLING SWINE WASTE KEYWORDS RECYCLING PERFORMANCE REFEEDING OXIDATION |
| 100 | 62 | 2535 | PERFORMANCE | FEEDING POTENTIAL OF RECLAIMED FECAL RESIDUE KEYWORDS FEEDS CATTLE PERFORMANCE REFEED |
| 100 | 75 | 2536 | PERFORMANCE | EFFECTS OF RECYCLING DRIED POULTRY WASTE ON YOUNG CHICKS KEYWORDS DIETS POULTRY PERFOR |
| 600 | 75 | 2537 | PERFORMANCE | MODEL TO PREDICT THE PERFORMANCE OF FEEDLOT CONTROL FACILITIES AT SPECIFIC OREGON LOCAT |
| 400 | 72 | 2538 | PERFORMANCE | FRESH WASTES HAVE MORE NUTRIENTS KEYWORDS POULTRY PERFORMANCE DIETS PROTEINS NUTRIENT |
| 700 | 63 | 2553 | PERFORMANCE | THE USE OF INDOOR LAGOONS FOR MANURE DISPOSAL IN HIGH DENSITY SYSTEMS OF POULTRY MANAGE |
| 300 | 65 | 2558 | PERFORMANCE | CHICKEN LITTER AS A SUPPLEMENT IN WINTERING BEEF COWS AND CALVES ON PASTURE KEYWORDS |
| 600 | 75 | 2559 | PERFORMANCE | COMPARISON OF DESIGN CRITERIA AND PERFORMANCE OF WASTE HANDLING SYSTEMS KEYWORDS DESI |
| 200 | 75 | 2643 | PERFORMANCE | RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED KEYWORDS AEROBIC-TREATMENT SLURR |
| 200 | 75 | 2645 | PERFORMANCE | NUTRITIONAL PATHOLOGICAL AND PARASITOLOGICAL EFFECTS OF FEEDING FEEDLOT WASTE TO BEEF C |
| 200 | 75 | 2647 | PERFORMANCE | NUTRITIONAL PROPERTIES OF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS KEYWORDS NUTR |
| 200 | 75 | 2653 | PERFORMANCE | CONVERSION OF ANIMAL WASTES TO FEED SUPPLEMENTS VIA THE ORGANIFORM PROCESS KEYWORDS O |
| 200 | 75 | 2654 | PERFORMANCE | HEALTH ASPECTS OF FEEDING ANIMAL WASTE CONSERVED IN SILAGE KEYWORDS PERFORMANCE SALMON |
| 200 | 75 | 2664 | PERFORMANCE | LONG TERM BROILER LITTER FERTILIZATION OF TALL FESCUE PASTURES AND HEALTH AND PERFORMAN |
| 200 | 75 | 2682 | PERFORMANCE | INFLUENCE OF ANTIBIOTICS AND GROWTH PROMOTING FEED ADDITIVES ON THE MANURING EFFECT OF |
| 200 | 75 | 2685 | PERFORMANCE | EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TO VARIATIONS IN CONCENTRATIONS OF SOD |
| 200 | 75 | 2707 | PERFORMANCE | A COMPUTER SIMULATION OF STORAGE AND LAND DISPOSAL OF SWINE WASTE KEYWORDS WASTE-STOR |
| 200 | 75 | 2709 | PERFORMANCE | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA KEYWORDS AGRIC |
| 200 | 75 | 2714 | PERFORMANCE | PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS KEYWORDS E |
| 200 | 75 | 2725 | PERFORMANCE | AEROBIC COMPOSTING-NEW BUILT-UP BED TECHNIQUE KEYWORDS AEROBIC-CONDITIONS EQUIPMENT UE |
| 200 | 75 | 2739 | PERFORMANCE | A LAGOON GRASS TERRACE SYSTEM TO TREAT SWINE WASTE KEYWORDS WASTE-TREATMENT ANAEROBIC- |
| 200 | 75 | 2741 | PERFORMANCE | SIMULATION OF FUNDAMENTAL ANAEROBIC LAGOON KINETICS KEYWORDS MODEL-STUDIES MATHEMATICA |
| 200 | 75 | 2744 | PERFORMANCE | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 200 | 75 | 2745 | PERFORMANCE | SURFACE AERATION-DESIGN AN PERFORMANCE FOR LAGOONS KEYWORDS AERATION DESIGN PERFORMAN |
| 200 | 75 | 2752 | PERFORMANCE | FERTILIZER VALUE OF LIVESTOCK WASTES KEYWORDS FERTILIZERS LIVESTOCK NUTRIENTS PERFORM |
| 400 | 64 | 2793 | PERFORMANCE | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 400 | 72 | 2805 | PERFORMANCE | FEEDLOT WASTE USABLE KEYWORDS FEEDLOTS RECYCLING FEEDS PERFORMANCE FRACTIONATION BUIL |
| 700 | 66 | 1679 | PERMEABILITY | TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS WAST |
| 200 | 71 | 1930 | PERMEABILITY | SEEPAGE LOSS FROM HOLDING PONDS KEYWORDS SEEPAGE-CONTROL PERMEABILITY HOLDING-PONDS |
| 300 | | 2117 | PERMEABILITY | FEEDLOT RUNOFF DISPOSAL ON GRASS OR CROPS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF IRRIG |
| 100 | 71 | 2413 | PERMEABILITY | SUBSURFACE DISTRIBUTION OF NITRATES BELOW COMMERCIAL CATTLE FEEDLOTS TEXAS HIGH PLAINS |
| 700 | 74 | 2564 | PERMEABILITY | PHYSICAL CHARACTERISTICS OF THE SURFACE AND INTERFACE LAYERS OF A LEVEL BEEF CATTLE FEE |
| 400 | 74 | 1799 | PERMITS | FARM POLLUTION-HOW REGULATIONS AFFECT YOU KEYWORDS PERMITS REGULATION LIVESTOCK FARM-W |
| 300 | 70 | 1814 | PERMITS | FEEDLOT POLLUTION KEYWORDS FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION |
| 100 | 73 | 1833 | PERMITS | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 300 | 69 | 2078 | PERMITS | WATER POLLUTION LAWS AND REGULATIONS KEYWORDS WATER-POLLUTION REGULATION MISSOURI PER |
| 300 | 72 | 2089 | PERMITS | ANIMAL WASTE-REGULATORY CONSIDERATIONS KEYWORDS WATER-POLLUTION REGULATION FEEDLOTS P |
| 200 | 74 | 2135 | PERMITS | AGRICULTURAL WASTE CONFERENCE KEYWORDS ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC |
| 200 | 74 | 2139 | PERMITS | ODOR PROBLEMS ASSOCIATED WITH AGRICULTURAL WASTE HANDLING KEYWORDS ODOR MICHIGAN AIR-P |
| 200 | 74 | 2140 | PERMITS | ECONOMIC IMPACT OF SELECTED POLLUTION CONTROL MEASURES ON BEEF AND DAIRY FARMS KEYWORD |
| 200 | 74 | 2142 | PERMITS | NPDES PERMIT SYSTEM AND GUIDELINES FOR MICHIGAN PRESENTED AT THE AGRICULTURAL WASTE CON |
| 300 | 74 | 2257 | PERMITS | CURRENT LIVESTOCK POLLUTION REGULATIONS KEYWORDS WATER-POLLUTION PERMITS LIVESTOCK PO |
| 300 | 75 | 2335 | PERMITS | ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES KEYWORDS LEGAL-ASPECTS REGULATION DAIR |
| 400 | 73 | 2429 | PERMITS | RACEWAYS-EXOTIC SPECIES MOST AFFECTED BY PROPOSED EPA DISCHARGE PERMITS KEYWORDS REGU |
| 200 | 73 | 2433 | PERMITS | STATUS OF THE ILLINOIS LIVESTOCK WASTE MANAGEMENT REGULATIONS KEYWORDS ILLINOIS LEGAL |
| 500 | 71 | 2524 | PERMITS | POLLUTION CONTROL TECHNIQUES AND REQUIREMENTS KEYWORDS REGULATION ILLINOIS AGRICULTURA |
| 200 | 75 | 2602 | PERMITS | PARTNERSHIP IN POLLUTION CONTROL KEYWORDS WATER-POLLUTION LEGISLATION FEEDLOTS ILLINO |
| 200 | 75 | 2603 | PERMITS | THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION |
| 400 | 74 | 2773 | PERMITS | THE EDITORS NOTEBOOK-ABOUT DISCHARGE REGULATIONS KEYWORDS CATFISHES RUNOFF PERMITS EN |
| 300 | 71 | 2077 | PEROXYACETYL-NITRA | AIR POLLUTION AND AGRICULTURE KEYWORDS AGRICULTURE AIR-POLLUTION ARIZONA POLLUTANTS S |
| 400 | 75 | 2055 | PERSIAN-GULF-COUNT | THEY PLAN TO EXPORT LIQUID MANURE TO THE ARABS KEYWORDS LIQUID-WASTES EXPORT FERTILIZE |
| 200 | 72 | 1880 | PESTICIDES | EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES |
| 300 | 73 | 1915 | PESTICIDES | METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURC |
| 200 | 71 | 1966 | PESTICIDES | SOIL POLLUTANTS AND THEIR EFFECTS ON CLEAN WATER KEYWORDS POLLUTANTS WATER-POLLUTION |
| 200 | 74 | 2017 | PESTICIDES | EUROPEAN APPROACHES TO THE CONTROL OF WATER POLLUTION PROBLEMS CAUSED BY AGRICULTURAL W |
| 300 | 73 | 2355 | PESTICIDES | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 600 | 74 | 2356 | PESTICIDES | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 200 | 71 | 2453 | PESTICIDES | AGRICULTURAL WASTES IN ARID ZONES KEYWORDS AGRICULTURAL-WASTES DOMESTIC-WASTES WATER- |
| 300 | | 2085 | PESTS | DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL- |
| 100 | 67 | 2192 | PESTS | COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATION KEYWORDS FEEDLOTS NUISANCE ZONING |
| 300 | | 2571 | PESTS | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 400 | 74 | 1810 | PEST-CONTROL | NO CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 100 | 75 | 2456 | PEST-CONTROL | WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE KEY |
| 100 | 74 | 2333 | PHENOLIC-ACIDS | PHENOLIC ACIDS AS INDICATORS OF POLLUTION WITH LIQUID MANURE-A METHOD FOR THEIR DETECTI |
| 600 | 70 | 1896 | PHOSPHATES | WATER QUALITY AND WASTE DISPOSAL IN MONTANA KEYWORDS WATER-QUALITY WASTE-DISPOSAL MONT |
| 200 | 71 | 1962 | PHOSPHATES | PROCEEDINGS OF CONFERENCES ON FARM ANIMAL WASTES NITRATES AND PHOSPHATES IN RURAL WISCO |

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| 300 | 74 | 2380 | PHOSPHATES | SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE KEYWORD |
| 100 | 70 | 2794 | PHOSPHATES | SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT KEYWORDS POULTRY PORTLAND-CEMENTS FLY-A |
| 700 | 71 | 1689 | PHOSPHATE | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 100 | 61 | 2534 | PHOSPHATE | WHAT IS POULTRY MANURE WORTH KEYWORDS POULTRY FERTILIZERS WASTE-TREATMENT RECYCLING L |
| 300 | 74 | 2380 | PHOSPHATE-FIXATION | SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE KEYWORD |
| 100 | 74 | 2525 | PHOSPHATE-REMOVAL | PHOSPHATE REMOVAL FROM DUCK FARM WASTES KEYWORDS WASTE-WATER-POLLUTION WASTE-WATER-TR |
| 200 | 75 | 2670 | PHOSPHATE-REMOVAL | OXIDATION NITRIFICATION AND DENITRIFICATION OF VEAL CALF MANURE KEYWORDS FERMENTATION |
| 200 | 72 | 1645 | PHOSPHORUS | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 200 | 72 | 1645 | PHOSPHORUS | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 100 | 73 | 1653 | PHOSPHORUS | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 73 | 1654 | PHOSPHORUS | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 100 | 74 | 1655 | PHOSPHORUS | THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N P AND K FERTILIZERS AND TO ANIMAL SLU |
| 300 | 72 | 1658 | PHOSPHORUS | CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM AGRICULTURAL LANDS KEYWORDS SEDIMENT-C |
| 100 | 69 | 1659 | PHOSPHORUS | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 600 | 74 | 1684 | PHOSPHORUS | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 300 | 74 | 1783 | PHOSPHORUS | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE G |
| 300 | 73 | 1829 | PHOSPHORUS | AREA NEEDED FOR LAND DISPOSAL OF BEEF AND SWINE WASTES KEYWORDS CATTLE SWINE WASTE-DIS |
| 300 | 74 | 1860 | PHOSPHORUS | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 300 | 71 | 1882 | PHOSPHORUS | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 600 | 74 | 1958 | PHOSPHORUS | LYSIMETER STUDIES WITH LONG TERM APPLICATION OF SWINE LAGOON EFFLUENT KEYWORDS LAGOON |
| 200 | 71 | 1967 | PHOSPHORUS | PHOSPHORUS IN OUR ENVIRONMENT KEYWORDS PHOSPHORUS FERTILIZERS SURFACE-WATERS ENVIRONM |
| 200 | 71 | 1968 | PHOSPHORUS | PHOSPHORUS IN THE RURAL ECOSYSTEM-RUNOFF FROM AGRICULTURAL LAND KEYWORDS PHOSPHORUS |
| 200 | 74 | 2032 | PHOSPHORUS | EFFECT OF LIQUID SWINE WASTE APPLICATION ON SOIL CHEMICAL COMPOSITION KEYWORDS LIQUID |
| 400 | 75 | 2055 | PHOSPHORUS | THEY PLAN TO EXPORT LIQUID MANURE TO THE ARABS KEYWORDS LIQUID-WASTES EXPORT FERTILIZ |
| 300 | 72 | 2063 | PHOSPHORUS | COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE KEYWORDS BURNING |
| 100 | 74 | 2064 | PHOSPHORUS | CORN SILAGE YIELD AND SOIL CHEMICAL PROPERTIES AS AFFECTED BY CATTLE FEEDLOT MANURE RE |
| 300 | 72 | 2086 | PHOSPHORUS | HYDROLOGY A [illegible] |
| 300 | 74 | 2100 | PHOSPHORUS | FACTS ON ME [illegible] |
| 400 | 74 | 2102 | PHOSPHORUS | FEEDLOT MAN [illegible] |
| 100 | 74 | 2108 | PHOSPHORUS | NUTRIENT TR [illegible] |
| 100 | 74 | 2109 | PHOSPHORUS | CHARACTERIS [illegible] |
| 100 | 73 | 2113 | PHOSPHORUS | EFFECTS OF [illegible] |
| 200 | 74 | 2144 | PHOSPHORUS | EFFECT OF M [illegible] |
| 300 | 74 | 2217 | PHOSPHORUS | COMPARISON [illegible] |
| 400 | 72 | 2231 | PHOSPHORUS | MANURE CAN [illegible] |
| 700 | 67 | 2234 | PHOSPHORUS | AEROBIC DIG [illegible] |
| 100 | 74 | 2236 | PHOSPHORUS | USING POULT [illegible] |
| 100 | 73 | 2277 | PHOSPHORUS | LONG TERM E [illegible] |
| 400 | 72 | 2302 | PHOSPHORUS | WHY POULTRY [illegible] |
| 400 | 72 | 2309 | PHOSPHORUS | PROCESSED P [illegible] |
| 100 | 74 | 2340 | PHOSPHORUS | RESULTS FRO [illegible] |
| 200 | 72 | 2361 | PHOSPHORUS | THE FATE OF [illegible] |
| 300 | 72 | 2371 | PHOSPHORUS | MINERAL ANA [illegible] |
| 200 | 70 | 2393 | PHOSPHORUS | PLANT NUTRI [illegible] |
| 100 | 65 | 2423 | PHOSPHORUS | VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL KEYWORDS NUTRIENTS NITROGEN PHOSPHORUS |
| 200 | 73 | 2442 | PHOSPHORUS | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES [illegible] |
| 300 | 74 | 2452 | PHOSPHORUS | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 700 | 70 | 2455 | PHOSPHORUS | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE KEYWOR |
| 200 | 73 | 2485 | PHOSPHORUS | AGRONOMIC CONSIDERATIONS IN ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL AGRONOMY CH |
| 100 | 74 | 2491 | PHOSPHORUS | SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY C |
| 400 | 72 | 2510 | PHOSPHORUS | SECOND THOUGHTS ABOUT RECYCLING POULTRY WASTES KEYWORDS RECYCLING POULTRY PHOSPHORUS E |
| 700 | 73 | 2532 | PHOSPHORUS | ALGAL GROWTH POTENTIAL OF SWINE WASTE KEYWORDS ALGAE GROWTH-RATES NUTRIENTS CHEMICAL- |
| 200 | 73 | 2548 | PHOSPHORUS | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY KEYWORDS POUL |
| 700 | 72 | 2569 | PHOSPHORUS | RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFF |
| 700 | 73 | 2577 | PHOSPHORUS | RATE AND EXTENT OF NITROGEN AND PHOSPHORUS MOVEMENT THROUGH GLACIALLY DEPOSITED SOILS T |
| 200 | 75 | 2590 | PHOSPHORUS | ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS I |
| 200 | 75 | 2628 | PHOSPHORUS | SUCCESSFUL MANURE MANAGEMENT SYSTEM FOR A LARGE COMMERCIAL HOG OPERATION KEYWORDS MA |
| 200 | 75 | 2646 | PHOSPHORUS | MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN HOUSE |
| 200 | 75 | 2710 | PHOSPHORUS | SETTLING CHARACTERISTICS OF SWINE MANURE AS RELATED TO DIGESTER LOADING KEYWORDS SEPA |
| 200 | 75 | 2746 | PHOSPHORUS | TREATMENT OF LIVESTOCK WASTES BY ENGINEERED LANDSCAPE WATER RENOVATION SYSTEM KEYWORDS |
| 200 | 75 | 2752 | PHOSPHORUS | FERTILIZER VALUE OF LIVESTOCK WASTES KEYWORDS FERTILIZERS LIVESTOCK NUTRIENTS PERFORM |
| 700 | 70 | 2781 | PHOSPHORUS | AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS KEYWOR |
| 200 | 72 | 2783 | PHOSPHORUS | MANURE HANDLING CAPACITY OF SOILS FROM A MICROBIOLOGICAL POINT OF VIEW KEYWORDS SOILS |
| 100 | 73 | 2812 | PHOSPHORUS | PHOSPHORUS IN PERCOLATES FROM MANURED LYSIMETERS KEYWORDS PHOSPHORUS PERCOLATION LYST |
| 300 | 73 | 1873 | PHOSPHORUS-CONTROL | DEVELOPMENT AND DEMONSTRATION OF NUTRIENT REMOVAL FROM ANIMAL WASTES KEYWORDS NITROGE |
| 300 | 74 | 1876 | PHOSPHORUS-CYCLE | FEASIBILITY OF OVERLAND FLOW TREATMENT OF FEEDLOT RUNOFF KEYWORDS AGRICULTURAL-RUNOFF |
| 200 | 70 | 2506 | PHOTOSYNTHESIS | AGRICULTURE AND NATURES NUTRIENT CYCLES KEYWORDS AGRICULTURE WATER-POLLUTION NITROGEN |
| 300 | 71 | 1866 | PHOTOSYNTHETIC-REC | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 700 | 71 | 1791 | PHYSICAL-CHARACTER | PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM KE |
| 700 | 70 | 1680 | PHYSICAL-PROPERTIE | EFFECT OF FEEDLOT LAGOON WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED NAV |
| 600 | 74 | 1684 | PHYSICAL-PROPERTIE | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 100 | 73 | 1773 | PHYSICAL-PROPERTIE | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS KEYWORDS DAIRY-INDUSTR |
| 100 | 73 | 1833 | PHYSICAL-PROPERTIE | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 600 | 74 | 1952 | PHYSICAL-PROPERTIE | EFFECT OF SPRINKLING ON LIQUID ANIMAL WASTE PROPERTIES KEYWORDS SPRINKLING LIQUID-WAST |
| 200 | 74 | 2015 | PHYSICAL-PROPERTIE | THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE |
| 600 | 72 | 2106 | PHYSICAL-PROPERTIE | EVALUATION OF METHODS FOR THE ANALYSIS OF PHYSICAL CHEMICAL AND BIOCHEMICAL PROPERTIES |
| 100 | 74 | 2130 | PHYSICAL-PROPERTIE | EFFECT OF EFFLUENT FROM BEEF FEEDLOTS ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOIL |
| 100 | 73 | 2134 | PHYSICAL-PROPERTIE | DRYING CHARACTERISTICS OF [illegible] POULTRY EXCRETA KEYWORDS POULTRY DRYING PHYSICAL-PRO |
| 200 | 74 | 2135 | PHYSICAL-PROPERTIE | AGRICULTURAL WASTE CONFERENCE KEYWORDS ANIMAL-WASTES DESIGN ECONOMICS RECYCLING CHEMIC |
| 200 | 74 | 2138 | PHYSICAL-PROPERTIE | COMPOSITION OF WASTE AS EXCRETED [illegible] |
| 200 | 74 | 2145 | PHYSICAL-PROPERTIE | UTILIZING THE NUTRIENTS IN ANIMAL MANURES KEYWORDS ANIMAL-WASTES [illegible] |
| 200 | 63 | 2155 | PHYSICAL-PROPERTIE | FOWL FECAL FA [illegible] |
| 200 | 63 | 2156 | PHYSICAL-PROPERTIE | MANURE DISPOS [illegible] |
| 600 | 72 | 2195 | PHYSICAL-PROPERTIE | ROOFED VS UNR [illegible] |
| 100 | 74 | 2222 | PHYSICAL-PROPERTIE | COMPARATIVE C [illegible] |
| 600 | 72 | 2262 | PHYSICAL-PROPERTIE | PROPERTIES RE [illegible] |
| 700 | 63 | 2311 | PHYSICAL-PROPERTIE | CHARACTERISTI [illegible] |
| 700 | 72 | 2316 | PHYSICAL-PROPERTIE | LIQUID-SOLID [illegible] |
| 700 | 73 | 2385 | PHYSICAL-PROPERTIE | PHYSICAL PROP [illegible] |
| 100 | 74 | 2408 | PHYSICAL-PROPERTIE | REVIEW PAPER- [illegible] |
| 100 | 75 | 2422 | PHYSICAL-PROPERTIE | WEATHERING OF [illegible] |
| 200 | 74 | 2462 | PHYSICAL-PROPERTIE | PRODUCTION OF METHANE FROM POULTRY MANURE KEYWORDS METHANE [illegible] |
| 200 | 74 | 2470 | PHYSICAL-PROPERTIE | WASTE HANDLING AND LAGOON MANAGEMENT KEYWORDS LAGOONS FEEDLOTS DESIGN CHEMICAL-PROPER |
| 100 | 74 | 2515 | PHYSICAL-PROPERTIE | PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE F |
| 300 | 74 | 2526 | PHYSICAL-PROPERTIE | COMPOSITION AND BIODEGRADABILITY OF CATTLE FECAL WASTE KEYWORDS CATTLE CHEMICAL-PROPERTI |
| 100 | 72 | 2580 | PHYSICAL-PROPERTIE | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFIN |
| 200 | 75 | 2687 | PHYSICAL-PROPERTIE | DECOMPOSITION [illegible] OF BEEF CATTLE WASTES KEYWORDS ORGANIC-WASTES CATTLE RECYCLING CHE |
| 200 | 75 | 2701 | PHYSICAL-PROPERTIE | EVAPORATION OF WATER FROM HOLDING PONDS KEYWORDS EVAPORATION PHYSICAL-PROPERTIES CHEM |
| 200 | 75 | 2712 | PHYSICAL-PROPERTIE | PROPERTIES OF SOLIDS AND LIQUIDS FROM STACKED MANURE KEYWORDS SOLID-WASTES LIQUID-WAST |
| 200 | 75 | 2715 | PHYSICAL-PROPERTIE | EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL KEYWORDS |

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200 75 2740  PHYSICAL-PROPERTIE PRESENT KNOWLEDGE ON THE EFFECTS OF LAND APPLICATION OF ANIMAL WASTE KEYWORDS ANIMAL-
700 64 2768  PHYSICAL-PROPERTIE CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT
100 74 2775  PHYSICAL-PROPERTIE EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO
100 71 2806  PHYSICAL-PROPERTIE AN ECOLOGICAL BLUEPRINT FOR TODAY KEYWORDS WASTE-DISPOSAL SAMPLING CHEMICAL-PROPERTIE
100 72 2811  PHYSICAL-PROPERTIE THE USE OF ANIMAL WASTES ON FERTILIZER KEYWORDS FERTILIZERS IRRIGATION ANIMAL-WASTES
200 75 2681  PHYTOPLANKTON      OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR L AND EUGLENA SP KEYWORDS
200 74 2765  PHYTOTOXICITY      ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE ON THE FEEDLOT SOIL PROFILE
100 74 1950  PH                 EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORD
600 74 1952  PH                 EFFECT OF SPRINKLING ON LIQUID ANIMAL WASTE PROPERTIES KEYWORDS SPRINKLING LIQUID-WAST
100 74 2236  PH                 USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL
100 73 2277  PH                 LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A
500 74 2285  PH                 POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS KEYWORDS POULTRY WAST
100 75 2293  PH                 NITRIFICATION IN SOILS INCUBATED WITH PIG SLURRY KEYWORDS NITRIFICATION SOILS SLURRIE
700 71 2300  PH                 NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA
700 65 2317  PH                 FERTILIZING VALUE OF CATTLE MANURE IN RELATION TO TREATMENT AND METHOD OF HANDLING KEY
300 71 2384  PH                 SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS
600 73 2416  PH                 POULTRY MANURE COMPOSTING KEYWORDS AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST
200 73 2480  PH                 AEROBIC TREATMENT OF LIVESTOCK WASTES KEYWORDS AEROBIC-TREATMENT LIVESTOCK DESIGN DAG
100 74 2491  PH                 SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TC FORAGE SORGHUM GROWN ON A COLD SILTY C
100 74 2502  PH                 A SURVEY OF EFFECTS OF ANIMAL WASTES ON STREAM POLLUTION FROM SELECTED DAIRY FARMS KEY
100 61 2505  PH                 THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI
100 75 2521  PH                 SOME EFFECTS OF FERTILIZERS AND FARMYARD MANURE ON THE ORGANIC PHOSPHORUS IN SOILS KEY
700 63 2553  PH                 THE USE OF INDOOR LAGOONS FOR MANURE DISPOSAL IN HIGH DENSITY SYSTEMS OF POULTRY MANAGE
700 72 2578  PH                 NITROGEN TRANSFORMATION AND MOVEMENT IN A MARINE SEDIMENT SOIL FOLLOWING TREATMENT WITH
200 75 2687  PH                 DECOMPOSITION RATES OF BEEF CATTLE WASTES KEYWORDS ORGANIC-WASTES CATTLE RECYCLING CHE
[illegible]
[illegible]                     NEW PUMPING SYSTEM FOR LIQUID MANURE KEYWORDS LIQUID-WASTES COSTS DESIGN WASTE-STORA
[illegible]
200 74 2155  PITS               FLUSHING SWINE WASTE KEYWORDS AERATION RECYCLING ODOR COSTS SWINE FLUSHING SLOTTED-FL
200 73 2474  PITS               CONFINEMENT SYSTEMS AND MANURE MANAGEMENT-STATE OF THE ART KEYWORDS CONFINEMENT-PENS
200 73 2481  PITS               FLUSH GUTTER SYSTEMS-CURRENT IOWA INSTALLATIONS KEYWORDS IOWA HYDRAULIC-SYSTEMS ANAERO
300 72 2090  PIT-DISPOSAL       EUTROPHICATION IN THE GREAT PLAINS KEYWORDS EUTROPHICATION GREAT-PLAINS WATER-POLLUTI
200 73 2474  PIT-STORAGE        CRITERIA FOR THE SELECTION OF A LIVESTOCK WASTE TREATMENT AND HANDLING SYSTEM KEYWORDS
300 73 1835  PLANNING           STRUCTURES AND ENVIRONMENT HANDBOOK KEYWORDS PLANNING ENVIRONMENT WASTE-DISPOSAL DESI
200 71 1972  PLANNING           PLANNING LAND APPLICATION OF MANURE KEYWORDS PLANNING AGRICULTURAL-RUNOFF SURFACE-WATE
400 72 2167  PLANNING           PLANNING FEEDLOT WASTE DISPOSAL KEYWORDS PLANNING FEEDLOTS WASTE-DISPOSAL WASTE-STORA
600 72 2489  PLANNING           PLANNING CONSIDERATIONS FOR CONFINEMENT SWINE FACILITIES KEYWORDS CONFINEMENT-PENS PL
100 71 1755  PLANTS             AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES KEYWORDS SAMPLING SOILS NI
200 64 2182  PLANTS             NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N
100 73 2121  PLANT-GROWTH       EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTE
300 74 1798  PLANT-RESPONSE     DESIGN PARAMETERS FOR ANIMAL WASTE TREATMENT SYSTEMS KEYWORDS LIQUID-AERATION-SYSTEMS
700 73 2792  PLANT-RESPONSE     THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE KE
200 74 2149  PLANT-SOIL-ENVIRON UTILIZING THE NUTRIENTS IN ANIMAL MANURES KEYWORDS ANIMAL-WASTES SOILS CHEMICAL-PROPER
400 75 2501  PLASTICS           MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS KEYWORDS RECYCLING BY-PRODUCTS FEED
600 74 1796  PLAYAS             ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN
400 73 1811  PLAYAS             AVERT RUNOFF POLLUTION KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P
200 75 2671  PLAYAS             SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN
900    1792  PLAYA-LAKE-DISPOSA SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF
100 73 2277  PLOW-DEPTH         LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A
200 75 2715  PLOW-FURROW-COVER  EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL KEYWORDS
100 74 2209  POINT-SOURCES      AGRICULTURAL WASTE MANAGEMENT KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL REGULATION WATE
200 75 2603  POINT-SOURCES      THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION
300 74 2257  POINT-SOURCE       CURRENT LIVESTOCK POLLUTION REGULATIONS KEYWORDS WATER-POLLUTION PERMITS LIVESTOCK PO
200 75 2597  POINT-SOURCE-DISCH ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTION CONTROL RULES ON THE UNITED STATES
300 70 1814  POINT-SOURCE-WASTE FEEDLOT POLLUTION KEYWORDS FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION
200 71 2453  POISONS            AGRICULTURAL WASTES IN ARID ZONES KEYWORDS AGRICULTURAL-WASTES DOMESTIC-WASTES WATER-
200 71 2453  POLITICAL-ASPECTS  AGRICULTURAL WASTES IN ARID ZONES KEYWORDS AGRICULTURAL-WASTES DOMESTIC-WASTES WATER-
[illegible]  POLLUTANTS         EFFECT OF ATMOSPHERIC AMMONIA AND THE STRESS OF INFECTIOUS BRONCHITIS VACCINATION ON L
[illegible]  POLLUTANTS         NATURE AND HISTORY OF THE NITRATE PROBLEM KEYWORDS NITRATES NITRITES POLLUTANTS WATER
[illegible]  POLLUTANTS         PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM KE
[illegible]  POLLUTANTS         FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT
[illegible]  POLLUTANTS         EFFECT OF CATTLE FEEDLOT WASTES UPON GROUND WATER-A COMMENTARY KEYWORDS FEEDLOTS GROU
[illegible]
600 71 1728  POLLUTION          LEGAL ASPECTS OF LIVESTOCK PRODUCTION AND WASTE MANAGEMENT KEYWORDS LEGAL-ASPECTS LIV
300 71 1739  POLLUTION          CATTLE FEEDLOT POLLUTION STUDY KEYWCRDS WASTE-TREATMENT WASTE-DISPOSAL CATTLE FEEDLOT
600 74 1751  POLLUTION          CHEMICAL CHANGES IN SOILS USED FOR BEEF MANURE CISPOSAL KEYWORDS CATTLE WASTE-DISPOSAL
400 73 1811  PCLLUTICN          AVERT RUNOFF POLLUTION KEYWORDS AGRICULTURAL-RUNCFF FEEDLOTS IRRIGATION EVAPORATION P
600 73 1813  POLLUTION          EXPERIENCE WITH A SPRAY RUNOFF SYSTEM FOR TREATING BEEF CATTLE FEEDLOT RUNOFF KEYWORDS
300 73 1825  POLLUTION          AREA NEEDED FOR LAND DISPOSAL OF BEEF AND SWINE WASTES KEYWORDS CATTLE SWINE WASTE-DIS
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200 69 1840  POLLUTION           PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT KEYWORDS  DRIED-POULTRY-WASTE R
100 71 1872  POLLUTION           AGRICULTURE THE SEEDS OF A PROBLEM  KEYWORDS  AGRICULTURE FARM-WASTES FORESTRY WASTE-DI
400 74 1921  POLLUTION           ABANDONED FEEDLOTS CAN POLLUTE MORE THAN ACTIVE ONES KEYWORDS  FEEDLOTS NITROGEN ABANDO
200 74 1996  POLLUTION           PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE  KEYWORDS REGULATION LEGAL-ASPECTS WAST
200 74 2003  POLLUTION           AN ENVIRONMENTAL ANALYSIS OF FEEDLOT SYSTEMS  KEYWORDS FEEDLOTS SYSTEMS-ANALYSES ENVIRO
300 72 2054  POLLUTION           PROFITABLE USE OF POULTRY MANURE  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL POULTRY NUTR
100 74 2057  POLLUTION           ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT USE MANURE  KEYWORDS
100 74 2109  POLLUTION           CHARACTERISTICS AND COMPARATIVE MAGNITUDE OF NONPOINT SOURCES  KEYWORDS  PRECIPITATION-
100 73 2113  POLLUTION           EFFECTS OF APPLICATION RATE IN DIRECT LAND DISPOSAL OF ANIMAL WASTES  KEYWORDS  EFFECTS
200 63 2153  POLLUTION           NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS  POULTRY WASTE-TREATME
100 72 2170  POLLUTION           DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION  KEYWORD
400 74 2203  POLLUTION           NUISANCE LAWSUITS-NEIGHBOR VS NEIGHBOR  KEYWORDS  LEGAL-ASPECTS WASTE-TREATMENT WASTE-D
100 72 2235  POLLUTION           FATE OF NITROGEN UNDER INTENSIVE ANIMAL FEEDING  KEYWORDS NITROGEN-COMPOUNDS FEEDLOTS O
400 75 2346  POLLUTION           CONSEQUENCES OF WASTE DISPOSAL ON LAND  KEYWORDS  WASTE-DISPOSAL ORGANIC-WASTES SEWAGE-
100 72 2359  POLLUTION           ANIMAL WASTE IN THE USA  KEYWORDS  ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR
700 70 2406  POLLUTION           EFFECT OF ANTIBIOTIC SUPPLEMENTATION ON THE DECOMPOSITION OF ANIMAL WASTES  KEYWORDS  A
400 72 2415  POLLUTION           CRITICAL WASTE PROBLEMS AHEAD  KEYWORDS  AGRICULTURAL-WASTES WASTE-DISPOSAL LAGOONS REC
300 71 2421  POLLUTION           WHOSE RESPONSIBILITY-CONTROL OF LIVESTOCK AND POULTRY WASTES  KEYWORDS  WASTE-DISPOSAL
300 70 2497  POLLUTION           AGRICULTURE AND THE POLLUTION PROBLEM  KEYWORDS  AGRICULTURE WATER-POLLUTION-CONTROL WA
700 70 2701  POLLUTION           AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS  KEYWOR
600 73 1602  POLLUTION-ABATEMEN  POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN  KEYWORDS  FAR
600 71 1729  POLLUTION-ABATEMEN  FDA S ROLE IN THE ANIMAL WASTE PROBLEM-PANEL DISCUSSION KEYWORDS  FARMS COSTS FEDERAL-G
300 69 1776  POLLUTION-ABATEMEN  POLLUTION IMPLICATIONS OF ANIMAL WASTES-A FORWARD ORIENTED  REVIEW  KEYWORDS  CATTLE HO
600 73 1892  POLLUTION-ABATEMEN  IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI  KEY
200 71 1925  POLLUTION-ABATEMEN  SOIL CONSERVATION SERVICE TEXAS TECH UNIVERSITY WORKSHOP COMMITTEE ON FEEDLOT WASTE  EF
200 71 1932  POLLUTION-ABATEMEN  SOIL CONSERVATION SERVICE STANDARD AND SPECIFICATIONS FOR POLLUTION ABATEMENT MEASURES
300 74 1959  POLLUTION-ABATEMEN  ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS  RECYCLING ANIMAL-
600 71 1985  POLLUTION-ABATEMEN  IRRIGATION RESIDUES  KEYWORDS  IRRIGATION-EFFECTS POLLUTANTS WATER-QUALITY-CONTROL WAST
[illegible]
200 74 2465  POLLUTION-CONTROL   HEN FLUSH FLUME SYSTEM WITH DEEP LAGOON  KEYWORDS  LAGOONS  ODOR FEEDLOTS CONFINEMENT-P
300 71 2516  POLLUTION-CONTROL   IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS  KEYWORDS MICHIGAN DAIRY-INDUSTRY LEGAL
500 71 2524  POLLUTION-CONTROL   POLLUTION CONTROL TECHNIQUES AND REQUIREMENTS  KEYWORDS REGULATION ILLINOIS AGRICULTURA
600 70 2530  POLLUTION-CONTROL   REVIEW OF RESEARCH AND RECOMMENDATIONS ON ANIMAL WASTE MANAGEMENT CONTROL MEASURES FOR
400 75 2547  POLLUTION-CONTROL   ON THE HORNS OF THE DAIRY WASTE DILEMMA  KEYWORDS  DAIRY-INDUSTRY CALIFORNIA REGULATION
200 75 2593  POLLUTION-CONTROL   ECONOMIC RESEARCH PERTAINING TO PROBLEMS OF LIVESTOCK WASTE MANAGEMENT AND POLLUTION CO
200 75 2600  POLLUTION-CONTROL   FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS  LEGISLATION FEED
200 75 2602  POLLUTION-CONTROL   PARTNERSHIP IN POLLUTION CONTROL  KEYWORDS  WATER-POLLUTION LEGISLATION FEEDLOTS ILLINO
200 75 2627  POLLUTION-CONTROL   A TOTAL RECYCLE UNIT SYSTEM FOR DAIRY MANURE MANAGEMENT KEYWORDS  RECYCLING DAIRY-INDUS
100 70 2763  POLLUTION-CONTROL   ROLE OF THE DAIRY AND FEED INDUSTRY IN ENVIRONMENTAL POLLUTION CONTROL  KEYWORDS  DAIRY
100 74 2333  POLLUTION-INDICATO  PHENOLIC ACIDS AS INDICATORS OF POLLUTION WITH LIQUID MANURE-A METHOD FOR THEIR DETECTI
600 71 2778  POLLUTION-POTENTIA  A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT
600 74 1748  POLYMERS            FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS KEYWORDS  FLOCCULATION CATTLE FL
400 73 1768  POLYSACCHARIDES     IS TOTAL RECYCLING OF HEN MANURE POSSIBLE  KEYWORDS  POULTRY RECYCLING FERMENTATION DIG
100 72 2190  PONDING             AGRICULTURAL RUNOFF CHARACTERISTICS AND CONTROL  KEYWORDS AGRICULTURAL-RUNOFF CONTROL E
300 74 1782  PONDS               POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS  KEYWORDS  FISH-FARMING
500 74 2132  PONDS               AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES  KEYWORDS  WASTE-TREATM
700 73 2212  PONDS               HYDROLOGY OF ANIMAL WASTE WATER PONDS  KEYWORDS  WASTE-WATER-POLLUTION PONDS HYDROLOGY
400 74 2232  PONDS               EPA AND THE FISH FARMER  KEYWORDS  FISH-FARMING REGULATIONS  EFFLUENT PONDS SUSPENDED-S
100 71 2413  PONDS               SUBSURFACE DISTRIBUTION OF NITRATES BELOW COMMERCIAL CATTLE FEEDLOTS TEXAS HIGH PLAINS
200 75 2603  POND-ENRICHMENT     OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR  L AND EUGLENA SP  KEYWORDS
300 72 2533  POND-MANAGEMENT     DAIRY WASTE STORAGE PONDS FOR SOIL PLANT RECYCLING  KEYWORDS  DAIRY-INDUSTRY WASTE-STOR
200 71 1927  POPULATION-DENSITY  REDUCTION OF FEEDLOT WASTE BY STABILIZATION  KEYWORDS FEEDLOTS CATTLE WASTE-MANAGEMENT
200 75 2630  PORK-PRODUCTION     SWINE PRODUCTION AND WASTE MANAGEMENT-STATE OF THE ART KEYWORDS  SWINE ECONOMICS STATE-
100 74 2292  POROSITY            FEEDLOT WASTE EFFECTS ON SOIL CONDITIONS AND WATER EVAPORATION  KEYWORDS  FEEDLOTS EFFE
100 73 1793  POROUS-MEDIA        DISPERSION DURING FLOW IN POROUS MEDIA WITH BILINEAR ABSORPTION  KEYWORDS  DISPERSION F
100 72 2170  POROUS-MEDIA        DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION  KEYWORD
700 69 2080  POROUS-STRATUM      MASS TRANSFER FROM A PACKED BED TO A WELL STIRRED SOLUTION  AND THE MEASUREMENT OF THE
100 70 2794  PORTLAND-CEMENTS    SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT  KEYWORDS POULTRY PORTLAND-CEMENTS FLY-A
300 73 2355  PORT-BYRON-SILT-LO  SWINE WASTE MANAGEMENT  KEYWORDS  CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID
600 74 2356  PORT-BYRON-SILT-LO  SWINE WASTE MANAGEMENT  KEYWORDS  CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID
[illegible]
100 73 2277  POTASSIUM           LONG TERM EFFECTS OF MANURE FERTILIZER AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS A
400 72 2302  POTASSIUM           WHY POULTRY MANURE VARIES AS FERTILIZER  KEYWORDS  POULTRY  FERTILIZERS NITROGEN PHOSPH
100 74 2340  POTASSIUM           RESULTS FROM EXPERIMENTS MEASURING THE EFFECTS OF LARGE AMOUNTS OF FERTILIZER AND OF FA
300 72 2371  POTASSIUM           MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS  KEYWORDS FEEDS MINNESOTA ANALYSES PHOS
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| 300 | 72 | 2374 | POTASSIUM | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 300 | 74 | 2452 | POTASSIUM | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 700 | 70 | 2455 | POTASSIUM | CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE KEYWOR |
| 600 | 74 | 2566 | POTASSIUM | LAND DISPOSAL OF BROILER LITTER-CHANGES IN SOIL POTASSIUM CALCIUM AND MAGNESIUM KEYWOR |
| 700 | 72 | 2569 | POTASSIUM | RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFF |
| 200 | 75 | 2718 | POTASSIUM | SETTLING CHARACTERISTICS OF SWINE MANURE AS RELATED TO DIGESTER LOADING KEYWORDS SEPA |
| 200 | 75 | 2752 | POTASSIUM | FERTILIZER VALUE OF LIVESTOCK WASTES KEYWORDS FERTILIZERS LIVESTOCK NUTRIENTS PERFORM |
| 300 | 74 | 2765 | POTASSIUM | ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE ON THE FEEDLOT SOIL PROFILE |
| 600 | 69 | 2079 | POTASSIUM-PERMANGA | ODOR CONTROL IN CATTLE FEED YARDS KEYWORDS ODOR MECHANICAL-CONTROL LEGAL-ASPECTS SPRA |
| 600 | 73 | 1618 | POULTRY | THEY BEAT THE HIGH COST OF PROTEIN WITH PLS KEYWORDS COSTS PROTEINS FEEDS POULTRY LIT |
| 300 | 72 | 1621 | POULTRY | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR |
| 300 | 65 | 1631 | POULTRY | THEORETICAL CONSIDERATIONS OF ANAEROBIC [illegible] FOR POULTRY WASTES KEYWORDS ANAEROBIC |
| 600 | 73 | 1632 | POULTRY | FEEDING STEERS DPW KEYWORDS FEEDS POULTRY CATTLE PROTEINS PERFORMANCE DEHYDRATED-POUL |
| 200 | 68 | 1642 | POULTRY | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 200 | 68 | 1643 | POULTRY | MICROBIOLOGICAL ASPECTS OF POULTRY WASTES KEYWORDS EXCRETA POULTRY MICROBIOLOGY NUTRIE |
| 200 | 72 | 1645 | POULTRY | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 200 | 71 | 1646 | POULTRY | SYSTEMS AND SITUATIONS FOR HANDLING POULTRY WASTES KEYWORDS POULTRY WASTE-HANDLING BE |
| 100 | 72 | 1681 | POULTRY | CRICATICA WHEEL ELIMINATES ODORS MANURE HANDLING AND POLLUTION KEYWORDS WASTE-HANDLIN |
| 600 | 74 | 1686 | POULTRY | AEROBIC TREATMENT OF POULTRY WASTES KEYWORDS AEROBIC-TREATMENT FARM-WASTES POULTRY CO |
| 200 | 66 | 1691 | POULTRY | SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS POULTRY EXCRE |
| 200 | 66 | 1692 | POULTRY | WASTE DISPOSAL CONCEPTS KEYWORDS WASTE-DISPOSAL EXCRETA POULTRY LAGOONS ANAEROBIC-DIG |
| 200 | 66 | 1693 | POULTRY | PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL-AEROBIC STABILI |
| 200 | 66 | 1694 | POULTRY | ODORS AND THEIR CONTROL KEYWORDS ODOR CONTROL EQUIPMENT POULTRY EXCRETA FEATHERS ANAE |
| 200 | 66 | 1698 | POULTRY | HYDRAULIC COLLECTION OF POULTRY WASTE KEYWORDS POULTRY HYDRAULIC-COLLECTION ODOR COST |
| 200 | 66 | 1699 | POULTRY | HYDRAULIC MANURE HANDLING IN LAYING HOUSES KEYWORDS HYDRAULIC-MANURE-HANDLING POULTRY |
| 200 | 66 | 1701 | POULTRY | LIQUID HANDLING PROCESSES FOR POULTRY MANURE UTILIZATION KEYWORDS LIQUID-WASTES WASTE- |
| 200 | 66 | 1702 | POULTRY | LAGOON—SINK OR SWIM KEYWORDS LAGOONS POULTRY ODOR |
| [illegible] | [illegible] | [illegible] | POULTRY | [illegible] |
| 100 | 71 | 1801 | POULTRY | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE |
| 600 | 73 | 1815 | POULTRY | ELECTRICALLY MANAGING WASTE FROM CAGE LAYERS KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL |
| 200 | 69 | 1824 | POULTRY | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
| 400 | 74 | 1827 | POULTRY | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AR |
| 100 | 73 | 1828 | POULTRY | THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID |
| 100 | 71 | 1849 | POULTRY | THE USE OF FORMALDEHYDE FLAKES AS AN ANTIMICROBIAL AGENT IN BUILT UP POULTRY LITTER KE |
| 100 | 71 | 1864 | POULTRY | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 100 | 71 | 1865 | POULTRY | ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL KEYWORDS POULTRY NITROGEN CARBON A |
| 300 | 71 | 1866 | POULTRY | PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES KEYWORDS SOLID-WAS |
| 200 | 74 | 1867 | POULTRY | SURMOUNTING THE POULTRY WASTE PROBLEM KEYWORDS POULTRY EXCRETA WASTE-MANAGEMENT ANAER |
| 200 | 74 | 1868 | POULTRY | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 200 | 74 | 1870 | POULTRY | EVALUATION OF POULTRY MANURE AS A FEED INGREDIENT KEYWORDS POULTRY EXCRETA DRIED-POULT |
| 600 | 72 | 1893 | POULTRY | LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD |
| 300 | 66 | 1897 | POULTRY | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION KEYWORDS POULTRY CHE |
| 300 | 71 | 1903 | POULTRY | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 100 | 71 | 1906 | POULTRY | ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE KEYWORDS ODOR GASE |
| 100 | 71 | 1910 | POULTRY | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 400 | 74 | 1911 | POULTRY | A CLOSED SYSTEM NEW IDEA IN POULTRY WASTE DISPOSAL KEYWORDS POULTRY RECYCLING EXCRETA |
| 600 | 74 | 1912 | POULTRY | AERATION OF POULTRY WASTES FOR ODOR AND NITROGEN CONTROL KEYWORDS POULTRY AERATION NIT |
| 600 | 74 | 1916 | POULTRY | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY REFEEDING |
| 400 | 73 | 1922 | POULTRY | KAOLIN RESULTS IN DRIER DROPPINGS KEYWORDS POULTRY ADDITIVES EXCRETA KAOLIN FLY-CONTR |
| 200 | 71 | 1932 | POULTRY | SOIL CONSERVATION SERVICE STANDARD AND SPECIFICATIONS FOR POLLUTION ABATEMENT MEASURES |
| 400 | 73 | 1946 | POULTRY | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 600 | 72 | 1954 | POULTRY | EXPERIENCES WITH OXIDATION DITCHES IN A PULLET GROWING HOUSE KEYWORDS POULTRY DESIGN C |
| 200 | 69 | 1980 | POULTRY | THE REUSE OF OLD LITTER KEYWORDS LITTER POULTRY REUSE BUILT-UP-LITTER MAREKS-DISEASE |
| 200 | 69 | 1981 | POULTRY | DEHYDRATION AN ECONOMICAL SOLUTION TO POULTRY MANURE PROBLEMS KEYWORDS DEHYDRATION EC |
| 200 | 69 | 1984 | POULTRY | A REVIEW OF AVAILABLE LITTER MATERIALS AND THEIR ADVANTAGES AND DISADVANTAGES KEYWORDS |
| 200 | 74 | 1998 | POULTRY | EFFLUENT REGULATIONS FOR LIVESTOCK AND POULTRY FEEDLOTS KEYWORDS ECONOMICS LEGAL-ASPEC |
| 200 | 74 | 2005 | POULTRY | INTEGRATED POULTRY MANURE HANDLING USING FLUSH TRAYS UNDER CAGES AND RENOVATED WASTEWA |
| 200 | 74 | 2008 | POULTRY | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 200 | 74 | 2009 | POULTRY | EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATIO |
| 200 | 74 | 2028 | POULTRY | APPROACHES FOR THE CONTROL OF NITROGEN WITH AN OXIDATION DITCH KEYWORDS NITROGEN CONT |
| 200 | 74 | 2035 | POULTRY | POSSIBLE WAYS OF ABATING THE NUISANCE OF SMELL CAUSED BY LIVESTOCK AND POULTRY FARMS B |
| 400 | 72 | 2038 | POULTRY | PROFIT TOO IN MANURE FROM PLASTIC PENS KEYWORDS FARM-WASTES POULTRY ECONOMICS WASTE-T |
| 400 | 74 | 2041 | POULTRY | THE MANY ASPECTS OF SANITATION IN POULTRY DISEASE CONTROL KEYWORDS ENVIRONMENTAL-SANIT |
| [illegible] | [illegible] | [illegible] | POULTRY | [illegible] |
| 200 | 63 | 2153 | POULTRY | NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS POULTRY WASTE-TREATME |
| 200 | 63 | 2154 | POULTRY | WASTE MANAGEMENT PROBLEMS ON THE FARM KEYWORDS POULTRY SPREADING SPRAYING HYDRAULIC-C |
| 200 | 63 | 2155 | POULTRY | FOWL FECAL FACTS KEYWORDS POULTRY PHYSICAL-PROPERTIES CHEMICAL-PROPERTIES BIOCHEMICAL |
| 200 | 63 | 2157 | POULTRY | INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL KEYWORDS LAGOONS POULTRY WASTE-DISPOSAL LO |
| 200 | 63 | 2158 | POULTRY | DIGESTION OF FARM POULTRY WASTES KEYWORDS ANAEROBIC-DIGESTION POULTRY WASTE-TREATMENT |
| 200 | 63 | 2159 | POULTRY | PROGRESS REPORT ON MANURE HARVESTING KEYWORDS POULTRY LIQUID-WASTES WASTE-STORAGE WAS |

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| 200 | 63 | 2160 | POULTRY | DEHYDRATION AND INCINERATION OF POULTRY MANURE KEYWORDS DEHYDRATION INCINERATION POULT |
| 200 | 63 | 2161 | POULTRY | AGRICULTURAL VALUE OF POULTRY MANURE KEYWORDS POULTRY ORGANIC-MATTER COSTS FERTILIZER |
| 200 | 63 | 2162 | POULTRY | WATER POLLUTION PREVENTION KEYWORDS WATER-POLLUTION GROUNDWATER LIVESTOCK POULTRY AGR |
| 200 | 63 | 2163 | POULTRY | PUBLIC HEALTH ASPECTS OF POULTRY WASTE MANAGEMENT KEYWORDS PUBLIC-HEALTH POULTRY COSTS |
| 200 | 63 | 2164 | POULTRY | SANITARY LANDFILLING OF POULTRY WASTES KEYWORDS POULTRY SOLID-WASTES COSTS MANURE SAN |
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| 400 | 74 | 2172 | POULTRY | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
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| 100 | 74 | 2189 | POULTRY | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
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| 100 | 67 | 2264 | POULTRY | LARVICIDAL ACTIVITY TO FLIES OF MANURE FROM CHICKS ADMINISTERED INSECTICIDE TREATED FEE |
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| 400 | 72 | 2306 | POULTRY | HOW NUTTING PRE-DRIES MANURE IN DEEP-PIT HOUSE KEYWORDS POULTRY DRYING MOISTURE-CONTEN |
| 300 | 61 | 2326 | POULTRY | INDOOR LAGOON FOR POULTRY MANURE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL WASTE-TREAT |
| 100 | 74 | 2327 | POULTRY | PERSISTENCE OF SALMONELLAE IN POULTRY EXCRETA KEYWORDS POULTRY SALMONELLA WASTE-STORAG |
| 400 | 75 | 2343 | POULTRY | AG ENGINEERS REVIEW NEW WASTE MANAGEMENT SYSTEMS KEYWORDS POULTRY NUTRIENTS ADDITIVES |
| 400 | 75 | 2345 | POULTRY | RECYCLING NUTRIENTS FOR LIVESTOCK KEYWORDS RECYCLING POULTRY REGULATION CALIFORNIA MI |
| 400 | 75 | 2353 | POULTRY | POULTRY LITTERS VALUE AS FERTILIZER CITED BY GEORGIAN KEYWORDS POULTRY LITTER FERTILIZ |
| 100 | 72 | 2357 | POULTRY | MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES KEYWORDS MICROBIAL |
| 100 | 71 | 2358 | POULTRY | INDUSTRIAL WASTE AND AGRICULTURE IN GLAMORGAN KEYWORDS INDUSTRIAL-WASTES AGRICULTURE R |
| 100 | 72 | 2359 | POULTRY | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR |
| 700 | 73 | 2379 | POULTRY | OXYGEN TRANSFER RELATIONSHIPS IN A POULTRY WASTE MIXED LIQUOR KEYWORDS WASTE-TREATMEN |
| 100 | 69 | 2380 | POULTRY | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS KEYWORDS WAST |
| 300 | 72 | 2386 | POULTRY | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
| 200 | 70 | 2392 | POULTRY | A PERSPECTIVE FOR CONNECTICUT KEYWORDS CONNECTICUT POULTRY DAIRY-INDUSTRY AGRICULTURA |
| 200 | 70 | 2398 | POULTRY | ROLE OF AGRICULTURE IN THE QUALITY OF THE NEW HAMPSHIRE ENVIRONMENT KEYWORDS AGRICULT |
| 100 | 48 | 2400 | POULTRY | RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE KEYWORDS FARM-WAST |
| 700 | 72 | 2401 | POULTRY | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY EQUAT |
| 300 | 48 | 2414 | POULTRY | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION KEYWORDS POULTRY FARM- |
| 100 | 75 | 2419 | POULTRY | ENSILED BROILER LITTER AND CORN FORAGE I FERMENTATION CHARACTERISTICS KEYWORDS FEEDS |
| 400 | 67 | 2420 | POULTRY | CANADIANS EXPLAIN ADVANTAGES PROBLEMS IN FEEDING POULTRY LITTER KEYWORDS FEEDS POULTR |
| 300 | 71 | 2421 | POULTRY | WHOSE RESPONSIBILITY-CONTROL OF LIVESTOCK AND POULTRY WASTES KEYWORDS WASTE-DISPOSAL |
| 100 | 75 | 2427 | POULTRY | USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS KEYWORDS DIETS PERFORMANCE AMINO-ACI |
| 200 | 73 | 2442 | POULTRY | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES LI |
| 300 | 74 | 2452 | POULTRY | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 100 | 75 | 2456 | POULTRY | WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE KEY |
| 200 | 74 | 2457 | POULTRY | PROCEEDINGS OF SYMPOSIUM ON THE CONVERSION OF POULTRY WASTE TO ENERGY FEED OR FERTILIZE |
| 200 | 74 | 2458 | POULTRY | THE MECHANICS OF AIR DRYING KEYWORDS POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB |
| 200 | 74 | 2461 | POULTRY | BRIOLER LITTER FOR CROP PRODUCTION KEYWORDS POULTRY FERTILIZERS COSTS CROP-PRODUCTION |
| 500 | 74 | 2503 | POULTRY | THE RECYCLING OF ORGANIC WASTE-INTENSIVE CATTLE PRODUCTION KEYWORDS RECYCLING ORGANIC |
| 400 | 72 | 2510 | POULTRY | SECOND THOUGHTS ABOUT RECYCLING POULTRY WASTES KEYWORDS RECYCLING POULTRY PHOSPHORUS E |
| 400 | 72 | 2511 | POULTRY | SHOULD SUPERPHOSPHATE BE USED ON MANURE KEYWORDS POULTRY DRYING FERTILIZERS ECONOMIC |
| 100 | 60 | 2518 | POULTRY | DISTRIBUTION OF THE MAJOR NITROGENOUS COMPOUNDS AND AMINO ACIDS IN CHICKEN URINE KEYWO |
| 300 | 72 | 2522 | POULTRY | THE USE AND VALUE OF ANIMAL WASTE AS FERTILIZER FOR CROP PRODUCTION KEYWORDS ANIMAL-W |
| 100 | 61 | 2534 | POULTRY | WHAT IS POULTRY MANURE WORTH KEYWORDS POULTRY FERTILIZERS WASTE-TREATMENT RECYCLING L |
| 100 | 75 | 2536 | POULTRY | EFFECTS OF RECYCLING DRIED POULTRY WASTE ON YOUNG CHICKS KEYWORDS DIETS POULTRY PERFOR |
| 400 | 72 | 2538 | POULTRY | FRESH WASTES HAVE MORE NUTRIENTS KEYWORDS POULTRY PERFORMANCE DIETS PROTEINS NUTRIENT |
| 400 | 60 | 2539 | POULTRY | MANURE DISPOSAL POSES PROBLEM KEYWORDS POULTRY WASTE-DISPOSAL FERTILIZERS COSTS ECONO |
| 400 | 69 | 2540 | POULTRY | APPLY MORE NOT LESS POULTRY LITTER TO REDUCE POLLUTION KEYWORDS AGRICULTURAL-RUNOFF AM |
| 300 | 75 | 2545 | POULTRY | INTEGRATED FLY CONTROL ON POULTRY RANCHES KEYWORDS PREDATORS SCAVENGERS POULTRY CALIFO |
| 700 | 63 | 2553 | POULTRY | THE USE OF INDOOR LAGOONS FOR MANURE DISPOSAL IN HIGH DENSITY SYSTEMS OF POULTRY MANAGE |
| 400 | 75 | 2560 | POULTRY | COLORADO DPW PROCESSING FIRM FINDS READY MARKET AS BOTH FEED FERTILIZER KEYWORDS COLO |
| 400 | 71 | 2572 | POULTRY | THE DRY DEEP PIT SYSTEM KEYWORDS POULTRY ODOR WATER-POLLUTION VENTILATION DEEP-PITS F |
| 700 | 73 | 2577 | POULTRY | RATE AND EXTENT OF NITROGEN AND PHOSPHORUS MOVEMENT THROUGH GLACIALLY DEPOSITED SOILS T |
| 700 | 72 | 2578 | POULTRY | NITROGEN TRANSFORMATION AND MOVEMENT IN A MARINE SEDIMENT SOIL FOLLOWING TREATMENT WITH |
| 200 | 75 | 2591 | POULTRY | AN ECONOMIC ANALYSIS OF METHANE GENERATION FEASIBILITY ON COMMERCIAL EGG FARMS KEYWORD |
| 200 | 75 | 2600 | POULTRY | FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS KEYWORDS LEGISLATION FEED |
| 200 | 75 | 2604 | POULTRY | TECHNIQUES THAT ARE SOLVING POLLUTION PROBLEMS FOR POULTRYMEN KEYWORDS POULTRY WASTE- |
| 200 | 75 | 2605 | POULTRY | MODIFICATIONS OF THE MICHIGAN STATE POULTRY IN-HOUSE DRYING SYSTEM KEYWORDS DESIGN MI |
| 200 | 75 | 2606 | POULTRY | DESIGN OF A POULTRY MANURE DRYING SYSTEM FOR A 155,000 LAYERS EGG FACTORY KEYWORDS DE |
| 200 | 75 | 2607 | POULTRY | IN-HOUSE MANURE DRYING-THE SLAT SYSTEM KEYWORDS DESIGN POULTRY DRYING ODOR VENTILATIO |
| 200 | 75 | 2642 | POULTRY | ENSILING POULTRY FLOOR LITTER AND CAGE LAYER MANURE KEYWORDS POULTRY LITTER ANALYSIS W |
| 200 | 75 | 2647 | POULTRY | NUTRITIONAL PROPERTIES OF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS KEYWORDS NUTR |
| 200 | 75 | 2652 | POULTRY | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 | 75 | 2658 | POULTRY | CHARACTERIZATION OF METHANE PRODUCTION FROM POULTRY MANURE KEYWORDS METHANE ANAEROBIC- |
| 200 | 75 | 2665 | POULTRY | MANURE FROM CAGED HENS EVALUATED ON FESCUE PASTURE KEYWORDS POULTRY FESCUES CROP-RESPO |
| 200 | 75 | 2677 | POULTRY | NITROGEN REMOVAL AND RECOVERY FROM POULTRY WASTEWATER BY ION EXCHANGE KEYWORDS POULTR |
| 200 | 75 | 2695 | POULTRY | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WAST |
| 200 | 75 | 2697 | POULTRY | MANAGEMENT OF ODORS ASSOCIATED WITH LIVESTOCK PRODUCTION KEYWORDS LIVESTOCK POULTRY EC |
| 200 | 75 | 2713 | POULTRY | MANAGEMENT OF A FLUSHING GUTTER MANURE REMOVAL SYSTEM TO IMPROVE ATMOSPHERIC QUALITY IN |
| 200 | 75 | 2721 | POULTRY | IN-HOUSE HANDLING AND DEHYDRATION OF POULTRY MANURE FROM A CAGED LAYER OPERATION A PRO |
| 200 | 75 | 2722 | POULTRY | DRYING OF POULTRY MANURE AN ECONOMIC AND TECHNICAL FEASIBILITY STUDY KEYWORDS ECONOMI |
| 200 | 75 | 2733 | POULTRY | A DESIGN APPROACH FOR THE USE OF AN OXIDATION DITCH FOR LIVESTOCK WASTE TREATMENT KEYW |
| 200 | 75 | 2734 | POULTRY | A THEORETICAL DESCRIPTION OF AEROBIC TREATMENT KEYWORDS AEROBIC-TREATMENT POULTRY MODE |
| 200 | 75 | 2736 | POULTRY | TURBINE AIR AERATION SYSTEM FOR POULTRY WASTES KEYWORDS POULTRY COSTS TURBINE-AIR-AERA |
| 200 | 75 | 2754 | POULTRY | POLLUTION ABATEMENT OF POULTRY MANURE BY MAXI-MIXING METHOD KEYWORDS POULTRY COSTS WAS |
| 200 | 75 | 2757 | POULTRY | COMPOSITION OF POULTRY MANURE AND EFFECT OF HEAVY APPLICATION ON SOIL CHEMICAL PROPERTI |
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| 100 | 71 | 2760 | POULTRY | POULTRY MANURE AS A LIVESTOCK FEED PART 1 KEYWORDS POULTRY LIVESTOCK REFEEDING HEN-LAY |
| 100 | 71 | 2761 | POULTRY | POULTRY MANURE AS A LIVESTOCK FEED PART 2 KEYWORDS POULTRY LIVESTOCK REFEEDING SOUTH- |
| 700 | 64 | 2768 | POULTRY | CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT |
| 700 | 72 | 2770 | POULTRY | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY DRYIN |
| 700 | 71 | 2771 | POULTRY | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |

# KEYWORD INDEX

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|---|---|---|---|---|
| 100 | 73 | 2779 | POULTRY | HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE  KEYWORDS  COMPOSTING MUNIC |
| 100 | 74 | 2784 | POULTRY | REGIONAL MANAGEMENT OF ANIMAL MANURES-A MODEL FOR COLLECTION STORAGE LOCATION AND DISTR |
| 100 | 71 | 2787 | POULTRY | WINTER HIGH RATE COMPOSTING OF BROILER MANURE  KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 400 | 64 | 2793 | POULTRY | CHICKEN LITTER COW FEED  KEYWORDS  FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 100 | 70 | 2794 | POULTRY | SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT  KEYWORDS POULTRY PORTLAND-CEMENTS FLY-A |
| 100 | 72 | 2801 | POULTRY | RESEARCH AND TECHNOLOGY  KEYWORDS  RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 100 | 72 | 2804 | POULTRY | REMOVING THE SMELL FROM MANURE  KEYWORDS  POULTRY FEEDS DRYING AFTER-BURNER ODOR-REMOVA |
| 100 | 75 | 2813 | POULTRY | CORN RESPONSE AND SOIL NITROGEN TRANSFORMATIONS FOLLOWING VARIED APPLICATION OF POULTRY |
| 200 | 75 | 2651 | POULTRY-ANAPHAGE | A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION |
| 200 | 74 | 1871 | POULTRY-HOUSES | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODORS AND DECOMPOSE ORGANIC W |
| 400 | 71 | 2271 | POULTRY-HOUSES | POULTRY HOUSES THAT MAKE GOOD NEIGHBORS  KEYWORDS  ODOR DUSTS VENTILATION AMMONIA GASES |
| 400 | 71 | 2276 | POULTRY-HOUSES | THE FALLACY OF DEEP PITS FOR POULTRY HOUSES  KEYWORDS DESIGN VENTILATION NUTRIENTS COST |
| 400 | 75 | 2349 | POULTRY-LITTER | RECYCLING POULTRY LITTER AS SILAGE  KEYWORDS  RECYCLING SILAGE CATTLE WEIGHT TASTE POUL |
| 200 | 74 | 2462 | POULTRY-MANURE | PRODUCTION OF METHANE FROM POULTRY MANURE  KEYWORDS  METHANE RESEARCH-AND-DEVELOPMENT C |
| 200 | 74 | 1871 | POULTRY-PROCESSING | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODORS AND DECOMPOSE ORGANIC W |
| 200 | 74 | 1871 | POULTRY-RENDERING- | THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODORS AND DECOMPOSE ORGANIC W |
| 400 | 68 | 2378 | POULTRY-WASTES | MANAGEMENT AND UTILIZATION OF POULTRY WASTES  KEYWORDS LITTER WASTE-TREATMENT WASTE-DIS |
| 400 | 75 | 2038 | POULTRY-WASTE | POULTRY WASTE FOR CATFISH  KEYWORDS  CATFISHES DIETS PERFORMANCE PROTEINS POULTRY-WASTE |
| 200 | 73 | 2548 | POUTRY | EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY  KEYWORDS  POUT |
| 600 | 72 | 1953 | POWER-REQUIREMENTS | A MECHANIZED COMPOST CHANNEL FOR ANIMAL WASTE  KEYWORDS DESIGN-DATA MECHANIZED-COMPOST- |
| 400 | 73 | 1740 | PRECIPITATION | RUNOFF CONTROL SYSTEMS FOR CONCRETE DAIRY CATTLE YARDS KEYWORDS  CATTLE DAIRY-INDUSTRY |
| 700 | 67 | 1838 | PRECIPITATION | WATER POLLUTION POTENTIAL OF CATTLE FEEDLOT RUNOFF  KEYWORDS  FEEDLOTS AGRICULTURAL-RUN |
| 300 | 75 | 2411 | PRECIPITATION | SURFACE RUNOFF IN DAIRIES  KEYWORDS  AGRICULTURAL-RUNOFF DAIRY-INDUSTRY WATER-POLLUTION |
| 200 | 75 | 2672 | PRECIPITATION | NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS  KEYWORDS  WINTER AGRICUL |
| 300 | 73 | 1617 | PRECIPITATION-ATMO | PREVAILING WINDS IN FEEDLOT SITE SELECTION  KEYWORDS  FEEDLOTS SITE-SELECTION WIND ODOR |
| 300 | 74 | 1860 | PRECIPITATION-ATMO | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS  NUTRIENTS EUTROPH |
| 600 | 72 | 1992 | PRECIPITATION-ATMO | EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM KEYWORDS  CLIMATOLOGY FEEDL |
| 100 | 74 | 2109 | PRECIPITATION-ATMO | CHARACTERISTICS AND COMPARATIVE MAGNITUDE OF NONPOINT SOURCES  KEYWORDS  PRECIPITATION- |
| 700 | 73 | 2212 | PRECIPITATION-ATMO | HYDROLOGY OF ANIMAL WASTE WATER PONDS  KEYWORDS  WASTE-WATER-POLLUTION PONDS HYDROLOGY |
| 700 | 67 | 2228 | PRECIPITATION-ATMO | ANNUAL TOTALS AND TEMPORAL DISTRIBUTION OF CATTLE FEEDLOT RUNOFF IN KANSAS  KEYWORDS  A |
| 400 | 70 | 2803 | PRECIPITATION-ATMO | FEEDLOT POLLUTION-A SOLVABLE PROBLEM  KEYWORDS  AGRICULTURAL-RUNOFF WATER-POLLUTION SOU |
| 300 | 75 | 2545 | PREDATORS | INTEGRATED FLY CONTROL ON POULTRY RANCHES  KEYWORDS PREDATORS SCAVENGERS POULTRY CALIFO |
| 200 | 74 | 2023 | PREDICTION | A FUNDAMENTAL APPROACH TO ANAEROBIC LAGOON ANALYSIS  KEYWORDS  MATHEMATICAL-MODELS ANAL |
| 200 | 75 | 2706 | PREDICTION-EQUATIO | ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS  KEYWORDS  AGRICUL |
| 300 | 73 | 1873 | PREDICTIVE-RELATIO | DEVELOPMENT AND DEMONSTRATION OF NUTRIENT REMOVAL FROM ANIMAL WASTES  KEYWORDS  NITROGE |
| 300 | 66 | 1897 | PRESERVATION | CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION  KEYWORDS  POULTRY CHE |
| 300 | 48 | 2414 | PRESERVATION | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION  KEYWORDS  POULTRY FARM- |
| 400 | 75 | 2056 | PRESERVATIVES | MILK PLUS MANURE-HIGHER DAIRY PROFITS  KEYWORDS  SEPARATION-TECHNIQUES DAIRY-INDUSTRY L |
| 400 | 74 | 1769 | PRESSURE | CONVERTING ANIMAL WASTES TO OIL  KEYWORDS  OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 100 | 73 | 1773 | PRESS-CAKE | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS  KEYWORDS  DAIRY-INDUSTR |
| 600 | 72 | 2074 | PROCEDURES | RECOVERING PROTEIN FROM ANIMAL WASTE  KEYWORDS  PROTEINS ANIMAL-WASTES CATTLE FEEDS THE |
| 400 | 74 | 1885 | PROCESSING | CALIFORNIA ISSUES DPW REGULATIONS  KEYWORDS  REGULATION DRIED-ANIMAL-WASTES LICENSE PRO |
| 100 | 74 | 1950 | PROCESSING | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS  KEYWORD |
| 500 | 74 | 2132 | PROCESSING | AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES  KEYWORDS  WASTE-TREATM |
| 600 | 67 | 2178 | PROCESSING | MANURE SLURRY STORAGE PROCESSING AND PUMPING  KEYWORDS  WASTE-STORAGE PUMPING SLURRIES |
| 400 | 75 | 2330 | PROCESSING | BRITISH GROUP ENCOURAGING WASTE RECYCLING  KEYWORDS RECYCLING FARM-WASTES GREAT-BRITAIN |
| 400 | 60 | 2539 | PROCESSING | MANURE DISPOSAL POSES PROBLEM  KEYWORDS  POULTRY WASTE-DISPOSAL FERTILIZERS COSTS ECONO |
| 100 | 75 | 2244 | PROCESSING-METHOD | EFFECT OF PROCESSING METHOD ON PASTURIZATION AND NITROGEN COMPONENTS OF BROILER LITTER |
| 600 | 71 | 1728 | PRODUCTION | LEGAL ASPECTS OF LIVESTOCK PRODUCTION AND WASTE MANAGEMENT  KEYWORDS  LEGAL-ASPECTS LIV |
| 400 | 74 | 1772 | PRODUCTION | DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS  POULTRY FEEDS DIET |
| 100 | 73 | 2176 | PRODUCTION | RECYCLING ENERGY AND AGRICULTURAL ECONOMICS  KEYWORDS RECYCLING ECONOMICS AGRICULTURE E |
| 200 | 74 | 2185 | PRODUCTION | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 200 | 74 | 2462 | PRODUCTION | PRODUCTION OF METHANE FROM POULTRY MANURE  KEYWORDS  METHANE RESEARCH-AND-DEVELOPMENT C |
| 400 | 72 | 2538 | PRODUCTION | FRESH WASTES HAVE MORE NUTRIENTS  KEYWORDS  POULTRY PERFORMANCE DIETS PROTEINS NUTRIENT |
| 100 | 71 | 2807 | PRODUCTION-RATES | INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIAL |
| 200 | 74 | 2007 | PRODUCTION-RATE | THE PRODUCTION RATE AND COMPOSITION OF MANURE FROM GROWING  TURKEYS  KEYWORDS  NUTRIENT |
| 200 | 74 | 2029 | PRODUCTIVITY | FORAGE AND GRAIN PRODUCTION FROM LAND USED FOR BEEF MANURE  DISPOSAL  KEYWORDS  PRODUCT |
| 300 | 75 | 2284 | PRODUCTIVITY | PROFITS FROM DAIRY MANURE APPLICATION  KEYWORDS  DAIRY-INDUSTRY COSTS PROFITS LIQUID-WA |
| 400 | 75 | 2346 | PRODUCTIVITY | CONSEQUENCES OF WASTE DISPOSAL ON LAND  KEYWORDS  WASTE-DISPOSAL ORGANIC-WASTES SEWAGE- |
| 300 | 75 | 2284 | PROFITS | PROFITS FROM DAIRY MANURE APPLICATION  KEYWORDS  DAIRY-INDUSTRY COSTS PROFITS LIQUID-WA |
| 600 | 72 | 1752 | PROFIT | ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE  KEYWORDS  AERATION LARVAE F |
| 100 | 74 | 2126 | PROPERTIES | AGRICULTURAL WASTES  KEYWORDS  LIVESTOCK PROPERTIES WASTE-TREATMENT REFEEDING LAND-DISP |
| 400 | 73 | 1618 | PROTEINS | THEY BEAT THE HIGH COST OF PROTEIN WITH PLS  KEYWORDS  COSTS PROTEINS FEEDS POULTRY LIT |
| 400 | 73 | 1632 | PROTEINS | FEEDING STEERS DPW  KEYWORDS  FEEDS POULTRY CATTLE PROTEINS PERFORMANCE DEHYDRATED-POUL |
| 400 | 74 | 1636 | PROTEINS | MANURE IS FOOD FOR PROTEIN  KEYWORDS  MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE |
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| 400 | 73 | 1858 | PROTEINS | FERMENTATION HEADS FOR HIGHER PRODUCTIVITY  KEYWORDS FERMENTATION RECYCLING WASTE-TREAT |
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| 400 | 74 | 1906 | PROTEINS | PROCESSED MANURE SEEN AS PROTEIN OF FUTURE  KEYWORDS CATTLE REFEEDING EXCRETA PROTEINS |
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| 100 | 73 | 2342 | PROTEINS | RECYCLED SWINE WASTE AS FEED KEYWORDS RECYCLING PROTEINS AMINO-ACIDS HEALTH REFEEDIN |
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| 400 | 75 | 2814 | PROTEINS | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 100 | 72 | 2059 | PROTEIN | RECYCLING OF ORGANIC WASTES WITH PROCESSING SYSTEM THAT PRECISELY CONTROLS HEAT AND FLO |
| 100 | 74 | 2189 | PROTEIN | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 200 | 74 | 1989 | PROTEIN-CONTENT | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS PER |
| 700 | 69 | 2060 | PSEUDO-DIFFUSIVITY | MASS TRANSFER FROM A PACKED BED TO A WELL STIRRED SOLUTION AND THE MEASUREMENT OF THE |
| 700 | 71 | 1766 | PSYCHROMETER | WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE KEY |
| 200 | 64 | 1697 | PUBLIC-HEALTH | SOCIAL AND LEGAL IMPLICATIONS OF ORGANIC WASTE MANAGEMENT KEYWORDS ORGANIC-WASTES MANA |
| 200 | 64 | 1703 | PUBLIC-HEALTH | HEALTH ASPECTS OF POULTRY WASTE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL PUBLIC-HEALTH |
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| 200 | 74 | 2035 | PUBLIC-NUISANCE-AC | POSSIBLE WAYS OF ABATING THE NUISANCE OF SMELL CAUSED BY LIVESTOCK AND POULTRY FARMS K |
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| 200 | 75 | 2615 | PUMPED-STORAGE | LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES- EARTHEN BASINS KEYWORDS DAIRY- |
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| 600 | 72 | 2262 | PUMPING | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR |
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| 200 | 75 | 2708 | PUMPING | MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES KEYWORDS IR |
| 200 | 73 | 2441 | PUMPS | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
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| 400 | 73 | 2552 | PUMPS | MOST PIG WASTE DISPOSAL SYSTEMS SATISFACTORY KEYWORDS LAGOONS DESIGN WASTE-DISPOSAL PU |
| 400 | 73 | 1811 | PUMP-OUT-SYSTEM | AVERT RUNOFF POLLUTION KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P |
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| 400 | 74 | 1771 | PURINA-RESEARCH-FA | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 200 | 74 | 2151 | PURPLE-SULFUR-BACT | AGRICULTURAL POLLUTION CONTROL LABORATORY KEYWORDS BACTERIA HYDROGEN-SULFIDE METHANE |
| 300 | 73 | 1622 | PYROLYSIS | THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS KEYWORDS RECYCLING QUALITATIVE-ORG |
| 400 | 74 | 1769 | PYROLYSIS | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
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| 100 | 72 | 2197 | PYROLYSIS | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
| 100 | 72 | 2314 | PYROLYSIS | FUEL FROM WASTES-A MINOR ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 300 | 72 | 2386 | PYROLYSIS | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
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| 100 | 72 | 2800 | PYROLYSIS | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
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| 300 | 73 | 1622 | QUALITATIVE-ORGANI | THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS KEYWORDS RECYCLING QUALITATIVE-ORG |
| 200 | 71 | 1926 | QUALITY | FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS KEYWORDS LIQUID-W |
| 100 | 73 | 1664 | QUANTITATIVE-ANALY | A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED |
| 200 | 71 | 1926 | QUANTITY | FACTORS AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE COLLECTIONS KEYWORDS LIQUID-W |
| 700 | 69 | 1656 | QUASILINEARIZATION | MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF KEYWORDS MATHEMATI |
| 400 | 74 | 2095 | QUINALDINE | URINARY EXCRETION OF QUINALDINE BY CHANNEL CATFISH KEYWORDS URINE CHANNEL-CATFISH QUI |
| 100 | 73 | 2325 | RABON | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
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| 300 | 69 | 2797 | RAINFALL | MANAGEMENT AND CONTROL OF BEEF FEEDLOT WASTE KEYWORDS FEEDLOTS CATTLE NEBRASKA REGULAT |
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| 600 | 71 | 1725 | RECYCLING | ANIMAL WASTE REUSE KEYWORDS RECYCLING FEEDS POULTRY CATTLE PROTEINS INSECTICIDES COST |
| 700 | 69 | 1734 | RECYCLING | DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE KEYWORDS FEEDS RECYCLING WASTELAGE DIGEST |
| 600 | 73 | 1746 | RECYCLING | CATTLE MANURE TO PIPELINE GAS-A PROCESS STUDY KEYWORDS MANURE CATTLE GASES FUELS PIPEL |
| 200 | 69 | 1760 | RECYCLING | HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 300 | 73 | 1764 | RECYCLING | DAIRY WASTE MANAGEMENT KEYWORDS WASTE-MANAGEMENT DAIRY-INDUSTRY CATTLE WATER-POLLUTIO |
| 400 | 73 | 1768 | RECYCLING | IS TOTAL RECYCLING OF HEN MANURE POSSIBLE KEYWORDS POULTRY RECYCLING FERMENTATION DIG |
| 400 | 74 | 1769 | RECYCLING | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 200 | 70 | 1805 | RECYCLING | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 400 | 72 | 1819 | RECYCLING | GE ENTERS MANURE RECYCLING RACE KEYWORDS MANURE FEEDLOTS RECYCLING FEEDS PROTEINS MA |
| 200 | 69 | 1824 | RECYCLING | THE REUSE OF BROILER LITTER WITH LITTER LIFE-ITS EFFECT ON PERFORMANCE KEYWORDS POULT |
| 100 | 73 | 1833 | RECYCLING | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 400 | 72 | 1842 | RECYCLING | WLJ PREVIEWS FIRST COMMERCIAL MANURE SYSTEM KEYWORDS AEROBIC-TREATMENT LIQUID-WASTE-TRE |
| 400 | 73 | 1858 | RECYCLING | FERMENTATION HEADS FOR HIGHER PRODUCTIVITY KEYWORDS FERMENTATION RECYCLING WASTE-TREAT |
| 200 | 74 | 1868 | RECYCLING | DIGESTER A SOURCE OF BIOELECTRICITY KEYWORDS RECYCLING GASES POULTRY DIGESTER BIOCONV |
| 200 | 74 | 1869 | RECYCLING | RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM KEYWORDS RECYCLING DRIED-P |
| 300 | 73 | 1874 | RECYCLING | RECYCLING ANIMAL WASTES AS PROTEIN SOURCES KEYWORDS RECYCLING ANIMAL-WASTES PROTEINS R |
| 600 | 72 | 1901 | RECYCLING | FACTORS WHICH INFLUENCE THE UTILIZATION OF ANIMAL EXCRETA EITHER DIRECTLY BY ANIMALS OR |
| 400 | 74 | 1909 | RECYCLING | COOKING WITH COW POWER KEYWORDS METHANE ANAEROBIC-BACTERIA CATTLE FERTILIZERS RECYCLI |
| 100 | 71 | 1910 | RECYCLING | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 400 | 74 | 1911 | RECYCLING | A CLOSED SYSTEM NEW IDEA IN POULTRY WASTE DISPOSAL KEYWORDS POULTRY RECYCLING EXCRETA |
| 600 | 74 | 1916 | RECYCLING | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY REFEEDING |
| 400 | 74 | 1923 | RECYCLING | METHANE PRODUCTION NOT EASY OR PRACTICAL KEYWORDS METHANE MANURE CATTLE RECYCLING CRO |
| 400 | 72 | 1939 | RECYCLING | WASTE CONVERSION UNIT DEVELOPED KEYWORDS FEEDS METHANE FERMENTATION ANAEROBIC-CONDITI |
| 400 | 73 | 1946 | RECYCLING | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 300 | 74 | 1959 | RECYCLING | ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS RECYCLING ANIMAL- |
| 200 | 74 | 1986 | RECYCLING | DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS WASTE-DISPOSAL RE |
| 200 | 74 | 1989 | RECYCLING | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS PER |
| 200 | 74 | 1990 | RECYCLING | THE DEVELOPMENT OF MANURE HARVESTING PRACTICES FOR BEEF FEEDLOTS KEYWORDS FEEDLOTS MA |
| 200 | 74 | 1996 | RECYCLING | PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE KEYWORDS REGULATION LEGAL-ASPECTS WAST |
| 200 | 74 | 2020 | RECYCLING | INFLUENCE OF INGESTION OF ANAEROBIC LAGOON EFFLUENT ON GROWING SWINE KEYWORDS RECYCLI |
| 200 | 74 | 2024 | RECYCLING | TREATMENT OF BEEF WASTE BY A ROTATING BIOLOGICAL CONTACTOR KEYWORDS AEROBIC-TREATMENT |
| 400 | 72 | 2036 | RECYCLING | PROFIT TOO IN MANURE FROM PLASTIC PENS KEYWORDS FARM-WASTES POULTRY ECONOMICS WASTE-T |
| 400 | 75 | 2040 | RECYCLING | PROCESSED EXCRETA POTENTIALLY NUTRITIONAL KEYWORDS CATTLE FEEDS PROTEINS RECYCLING PE |
| 400 | 72 | 2046 | RECYCLING | BREAKTHROUGH IN THE FIGHT AGAINST POLLUTION KEYWORDS THERMOPHILIC-BACTERIA WASTE-TREAT |
| 100 | 74 | 2047 | RECYCLING | CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING KEYWORDS RECYCLING OIL CATALYST |
| 100 | 74 | 2057 | RECYCLING | ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT USE MANURE KEYWORDS |
| 100 | 72 | 2059 | RECYCLING | RECYCLING OF ORGANIC WASTES WITH PROCESSING SYSTEM THAT PRECISELY CONTROLS HEAT AND FLO |
| 400 | 74 | 2065 | RECYCLING | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORDS IDAHO RECYCLIN |
| 400 | 73 | 2067 | RECYCLING | DRIED POULTRY MANURE UTILIZATION KEYWORDS RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO |
| 400 | 75 | 2071 | RECYCLING | DUNG HO-FDA SETS REGS ON RECYCLED FEED KEYWORDS REGULATION RECYCLING ANIMAL-WASTES FE |
| 600 | 72 | 2074 | RECYCLING | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS THE |
| 400 | 73 | 2091 | RECYCLING | RECYCLING POULTRY WASTE NOT FOR SMALL OPERATOR KEYWORDS RECYCLING ECONOMICS COSTS POUL |
| 300 | 74 | 2100 | RECYCLING | FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE KEYWORDS METHANE RECYCLING ENERGY ORGANI |
| 400 | 75 | 2107 | RECYCLING | FEEDLOT RECLAMATION CLOSED SYSTEM-WASTE RECOVERING-INSULATED KEYWORDS DESIGN CONSTRUC |
| 400 | 73 | 2115 | RECYCLING | ENZYMES DIGEST FIBER IN RECYCLED MANURE KEYWORDS RECYCLING POULTRY ENZYMES HEAT REFEE |
| 400 | 75 | 2125 | RECYCLING | CATTLE POULTRY PRODUCERS PUSH FOR RECYCLING RULES KEYWORDS CATTLE POULTRY ANIMAL-WAST |
| 200 | 74 | 2135 | RECYCLING | AGRICULTURAL WASTE CONFERENCE KEYWORDS ANIMAL-WASTES DESIGN MICHIGAN RECYCLING CHEMIC |
| 200 | 74 | 2150 | RECYCLING | FLUSHING SWINE WASTE KEYWORDS AERATION RECYCLING ODOR COSTS SWINE FLUSHING SLOTTED-FL |
| 200 | 74 | 2152 | RECYCLING | HANDLING DEHYDRATION AND UTILIZATION OF POULTRY WASTE KEYWORDS DEHYDRATION POULTRY REC |
| 200 | 72 | 2168 | RECYCLING | THERMOCHEMICAL EVALUATION OF ANIMAL WASTE CONVERSION PROCESSES KEYWORDS RECYCLING GAS |
| 400 | 74 | 2172 | RECYCLING | RECYCLED WASTE IN FEEDS DESCRIBED KEYWORDS RECYCLING FARM-WASTES FEEDS CATTLE POULTRY |
| 100 | 73 | 2176 | RECYCLING | RECYCLING ENERGY AND AGRICULTURAL ECONOMICS KEYWORDS RECYCLING ECONOMICS AGRICULTURE E |
| 300 | 74 | 2177 | RECYCLING | RECYCLING POULTRY WASTE AS FEED WILL IT PAY KEYWORDS RECYCLING FEEDS ECONOMICS INCINER |
| 200 | 73 | 2180 | RECYCLING | HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS KEYWORDS GASES RECYCLING CATTLE AU |
| 200 | 74 | 2185 | RECYCLING | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 400 | | 2191 | RECYCLING | HOW EGGMEN ARE SOLVING THE ECOLOGY PROBLEM KEYWORDS POULTRY ECOLOGY WASTE-STORAGE WAS |
| 100 | 72 | 2197 | RECYCLING | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
| 200 | 71 | 2206 | RECYCLING | PRINCIPLES OF NUTRIENT CONTROL FOR AGRICULTURAL WASTEWATERS KEYWORDS NUTRIENTS CONTRO |
| 100 | 74 | 2207 | RECYCLING | DIGESTION BY-PRODUCT MAY GIVE ANSWER TO ENERGY PROBLEM KEYWORDS ENERGY ANAEROBIC-DIGE |
| 400 | 72 | 2240 | RECYCLING | GENERAL ELECTRIC TO RECYCLE BEEF MANURE INTO PROTEIN FEED AT NEW ARIZONA PLANT KEYWORD |
| 400 | 75 | 2251 | RECYCLING | FERTILIZER FEED VALUE OF SWINE WASTES DETAILED KEYWORDS RECYCLING FERTILIZERS FEEDS SW |
| 400 | 72 | 2273 | RECYCLING | PROGRESS REPORTED IN HANDLING ANIMAL WASTES RECYCLING IN FEED KEYWORDS RECYCLING FEED |
| 200 | 73 | 2278 | RECYCLING | CONVERTING SWINE WASTE INTO A NUTRIENT SOURCE FOR SWINE KEYWORDS RECYCLING FEEDS NUTRI |
| 200 | 72 | 2279 | RECYCLING | NUTRIENT RECYCLING-MODERN ENERGY MANAGEMENT KEYWORDS NUTRIENTS RECYCLING ENERGY INCINE |
| 400 | 71 | 2294 | RECYCLING | FERMENTED POULTRY MANURE RECYCLED KEYWORDS RECYCLING FERMENTATION POULTRY SLURRIES MA |
| 400 | 72 | 2299 | RECYCLING | DPW RECYCLING FACTS UPDATED KEYWORDS RECYCLING COSTS PERFORMANCES LAYER-HENS DEHYDRAT |
| 400 | 72 | 2304 | RECYCLING | DATA NEEDED ON SAFETY OF RECYCLING WASTE KEYWORDS RECYCLING PATHOGENIC-BACTERIA SAFET |
| 100 | 72 | 2314 | RECYCLING | FUEL FROM WASTES-A MINOR ENERGY SOURCE KEYWORDS FUELS ORGANIC-WASTES ENERGY HYDROGENA |
| 400 | 72 | 2320 | RECYCLING | THINK OF MANURE AS A RESOURCE-NOT A WASTE KEYWORDS WATER-POLLUTION AGRICULTURAL-RUNOF |
| 400 | 75 | 2322 | RECYCLING | NEW MANURE CONVERSION PLANT OPENED KEYWORDS RECYCLING FERTILIZERS FEEDS AEROBIC-DIGES |
| 300 | 74 | 2323 | RECYCLING | OKLAHOMA MANURE FOR MIDWEST METHANE KEYWORDS METHANE FUELS OKLAHOMA RECYCLING CATTLE |
| 400 | 75 | 2324 | RECYCLING | WASTE CONVERSION CONCEPT DEVELOPED KEYWORDS RECYCLING AEROBIC-CONDITIONS BACTERIA CAT |
| 100 | 72 | 2328 | RECYCLING | THE OIL CONVERSION PROCESS-AN ASSESSMENT KEYWORDS RECYCLING OIL LIVESTOCK AGRICULTURAL |
| 100 | 72 | 2329 | RECYCLING | CONVERTING ORGANIC WASTES TO OIL KEYWORDS RECYCLING ORGANIC-WASTES OIL CELLULOSE CATT |

# KEYWORD INDEX

| | | |
|---|---|---|
| 400 75 2330 | RECYCLING | BRITISH GROUP ENCOURAGING WASTE RECYCLING KEYWORDS RECYCLING FARM-WASTES GREAT-BRITAIN |
| 100 74 2337 | RECYCLING | MANURE GETS REDISCOVERED KEYWORDS FEEDLOTS FERTILIZERS LIVESTOCK COSTS ENERGY NITRATE |
| 100 73 2342 | RECYCLING | RECYCLED SWINE WASTE AS FEED KEYWORDS RECYCLING PROTEINS AMINO-ACIDS HEALTH REFEEDIN |
| 400 75 2344 | RECYCLING | SEPARATING SOLID WASTE FROM LIQUID KEYWORDS SOLID-WASTES LIQUID-WASTES CATTLE RECYCL |
| 400 75 2345 | RECYCLING | RECYCLING NUTRIENTS FOR LIVESTOCK KEYWORDS RECYCLING POULTRY REGULATION CALIFORNIA MI |
| 100 73 2348 | RECYCLING | ULTIMATE IN RECYCLING KEYWORDS RECYCLING FEEDS RECLAMATION ECONOMICS FEEDLOTS CHEMICA |
| 400 75 2349 | RECYCLING | RECYCLING POULTRY LITTER AS SILAGE KEYWORDS RECYCLING SILAGE CATTLE WEIGHT TASTE POUL |
| 400 61 2360 | RECYCLING | MANURE SMELL FURNISHES FARMSTEADS POWER NEEDS KEYWORDS GASES FERTILIZERS ANAEROBIC-DIG |
| 300 72 2373 | RECYCLING | FEEDING VALUE OF CORN RECLAIMED FROM AN OXIDATION DITCH AND THE INFLUENCE OF ADDING WAT |
| 300 72 2386 | RECYCLING | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
| 100 70 2389 | RECYCLING | INDUSTRIAL AND AGRICULTURAL SOLID WASTES AND PROBLEMS INVOLVED IN THEIR DISPOSAL KEYWO |
| 200 70 2391 | RECYCLING | REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION KEYWORDS RE |
| 200 70 2397 | RECYCLING | A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES KEYWORDS RECYCLING FEEDS FERTILIZERS |
| 400 72 2415 | RECYCLING | CRITICAL WASTE PROBLEMS AHEAD KEYWORDS AGRICULTURAL-WASTES WASTE-DISPOSAL LAGOONS REC |
| 400 75 2425 | RECYCLING | UTILIZING WASTES IN ANIMAL FEEDS-A EUROPEAN OVERVIEW KEYWORDS RECYCLING ORGANIC-WASTE |
| 300 75 2426 | RECYCLING | USE OF SLUDGE RELIEVES FERTILIZER SHORTAGE KEYWORDS RECYCLING ENERGY FERTILIZERS SLUDG |
| 200 73 2436 | RECYCLING | MANURE HANDLING BY HYDRAULIC FLUSHING KEYWORDS DESIGN LIQUID-WASTES RECYCLING CONFINE |
| 300 74 2452 | RECYCLING | RECYCLING ANIMAL WASTES KEYWORDS RECYCLING FARM-WASTES POULTRY CATTLE FEEDS NITROGEN |
| 400 71 2454 | RECYCLING | WHY WASTE ANIMAL WASTES KEYWORDS WASTE-DISPOSAL RECYCLING LAGOONS ANIMAL-WASTES ECOLI |
| 200 74 2459 | RECYCLING | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 200 74 2463 | RECYCLING | BEEF IN CONFINEMENT WORKSHOP KEYWORDS FEEDLOTS CONFINEMENT-PENS CATTLE LEGAL-ASPECTS |
| 200 74 2468 | RECYCLING | RECYCLING ITS PROBLEMS AND OPPORTUNITIES KEYWORDS RECYCLING METHANE LAGOONS NUTRIENTS |
| 200 73 2484 | RECYCLING | RECIRCULATION EQUIPMENT DESIGN AND SELECTION KEYWORDS EQUIPMENT DESIGN HYDRAULIC-TRANS |
| 100 72 2500 | RECYCLING | THE BIO GAS PLANT-GENERATING METHANE FROM ORGANIC WASTES KEYWORDS RECYCLING ORGANIC-WA |
| 400 75 2501 | RECYCLING | MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS KEYWORDS RECYCLING BY-PRODUCTS FEED |
| 500 74 2503 | RECYCLING | THE RECYCLING OF ORGANIC WASTE-INTENSIVE CATTLE PRODUCTION KEYWORDS RECYCLING ORGANIC |
| 400 75 2508 | RECYCLING | EMERGING ISSUES IN FEEDLOT WASTE MANAGEMENT KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF RECY |
| 400 72 2510 | RECYCLING | SECOND THOUGHTS ABOUT RECYCLING POULTRY WASTES KEYWORDS RECYCLING POULTRY PHOSPHORUS E |
| 200 73 2529 | RECYCLING | POTENTIAL OF RECYCLING SWINE WASTE KEYWORDS RECYCLING PERFORMANCE REFEEDING OXIDATION |
| 100 61 2536 | RECYCLING | WHAT IS POULTRY MANURE WORTH KEYWORDS POULTRY FERTILIZERS WASTE-TREATMENT RECYCLING L |
| 300 74 2555 | RECYCLING | TWO TYPES OF DIGESTERS UNDER STUDY AT MSU-ANIMAL WASTE MANAGEMENT KEYWORDS AEROBIC-TR |
| 200 75 2590 | RECYCLING | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 200 75 2612 | RECYCLING | OPERATION OF A BEEF MANURE FLUSHING SYSTEM IN A COLD CLIMATE KEYWORDS CONFINEMENT-PENS |
| 200 75 2616 | RECYCLING | MILKING CENTER WASTE MANAGEMENT KEYWORDS DAIRY-INDUSTRY RECYCLING IRRIGATION EFFLUENT |
| 200 75 2617 | RECYCLING | WASTE MANAGEMENT AT HALL BROTHERS DAIRY KEYWORDS DAIRY-INDUSTRY CONFINEMENT-PENS SEPAR |
| 200 75 2624 | RECYCLING | DAIRY WASTE FIBER-A BYPRODUCT WITH A FUTURE KEYWORDS DAIRY-INDUSTRY SEPARATION-TECHNIQ |
| 200 75 2627 | RECYCLING | A TOTAL RECYCLE UNIT SYSTEM FOR DAIRY MANURE MANAGEMENT KEYWORDS RECYCLING DAIRY-INDUS |
| 200 75 2629 | RECYCLING | EXPERIENCE WITH OPEN GUTTER FLUSH SYSTEMS FOR SWINE MANURE MANAGEMENT KEYWORDS CONFI |
| 200 75 2631 | RECYCLING | SWINE WASTE NUTRIENT RECOVERY SYSTEM BASED ON THE USE OF THERMAL DISCHARGES KEYWORDS |
| 200 75 2641 | RECYCLING | RECOVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 200 75 2642 | RECYCLING | ENSILING POULTRY FLOOR LITTER AND CAGE LAYER MANURE KEYWORDS POULTRY LITTER ANALYSIS W |
| 200 75 2643 | RECYCLING | RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED KEYWORDS AEROBIC-TREATMENT SLURR |
| 200 75 2647 | RECYCLING | NUTRITIONAL PROPERTIES OF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS KEYWORDS NUTR |
| 200 75 2651 | RECYCLING | A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE MORTALITY RECYCLING HENS AND EGG PRODUCTION |
| 200 75 2652 | RECYCLING | ENSILING BROILER LITTER WITH CORN-FORAGE CORN-GRAIN AND WATER KEYWORDS POULTRY LITTER |
| 200 75 2656 | RECYCLING | SMALL METHANE GENERATOR FOR WASTE DISPOSAL KEYWORDS METHANE RECYCLING DESIGN SWINE TAI |
| 200 75 2657 | RECYCLING | PRODUCT APPLICATIONS OF TREATED LIVESTOCK WASTE KEYWORDS RECYCLING PIGMENTS FEEDLOTS C |
| 200 75 2677 | RECYCLING | NITROGEN REMOVAL AND RECOVERY FROM POULTRY WASTEWATER BY ION EXCHANGE KEYWORDS POULTR |
| 200 75 2687 | RECYCLING | DECOMPOSITION RATES OF BEEF CATTLE WASTES KEYWORDS ORGANIC-WASTES CATTLE RECYCLING CHE |
| 200 75 2703 | RECYCLING | ENERGETICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS KEYWORDS RECYCLING COSTS LIQUID-WAS |
| 200 75 2713 | RECYCLING | MANAGEMENT OF A FLUSHING GUTTER MANURE REMOVAL SYSTEM TO IMPROVE ATMOSPHERIC QUALITY IN |
| 200 75 2723 | RECYCLING | DRYING DAIRY WASTES WITH SOLAR ENERGY KEYWORDS DRYING COSTS COMPOSTING RECYCLING DAIR |
| 200 75 2738 | RECYCLING | TRENDS AND VARIATIONS IN AN ANAEROBIC LAGOON WITH RECYCLING KEYWORDS LAGOONS ANAEROBI |
| 200 75 2744 | RECYCLING | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWORDS WASTE-TREATME |
| 100 73 2779 | RECYCLING | HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE KEYWORDS COMPOSTING MUNIC |
| 200 71 2785 | RECYCLING | AGRICULTURAL WASTES-AN ENERGY RESOURCE OF THE SEVENTIES KEYWORDS RECYCLING ENERGY FUEL |
| 100 72 2800 | RECYCLING | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 100 72 2801 | RECYCLING | RESEARCH AND TECHNOLOGY KEYWORDS RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 400 72 2805 | RECYCLING | FEEDLOT WASTE USABLE KEYWORDS FEEDLOTS RECYCLING FEEDS PERFORMANCE FRACTIONATION BUIL |
| 400 75 2814 | RECYCLING | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 300 74 1914 | RECYCLING | PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING KEYWORDS AQUACULTURE WA |
| 100 72 1621 | REFEEDING | SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS A CRITICAL REVIEW KEYWORDS FEEDLOTS ODOR- |
| 400 74 1636 | REFEEDING | MANURE IS FOOD FOR PROTEIN KEYWORDS MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE |
| 200 72 1645 | REFEEDING | ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING KEYWORDS WASTE-MANAGEMENT NUTRIENTS REC |
| 200 71 1646 | REFEEDING | SYSTEMS AND SITUATIONS FOR HANDLING POULTRY WASTES KEYWORDS POULTRY WASTE-HANDLING RE |
| 400 74 1771 | REFEEDING | DPW S POULTRY FEED VALUE IS LIMITED KEYWORDS POULTRY FEEDS DRIED-POULTRY-WASTES REFEE |
| 400 74 1772 | REFEEDING | DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS KEYWORDS POULTRY FEEDS DIET |
| 400 74 1809 | REFEEDING | MANURE REFEEDING CUTS ODOR SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN KEYWORDS ELECTRIC |
| 200 69 1840 | REFEEDING | PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT KEYWORDS DRIED-POULTRY-WASTE R |
| 600 74 1847 | REFEEDING | CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION KEYWORDS LIQU |
| 200 74 1869 | REFEEDING | RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM KEYWORDS RECYCLING DRIED-P |
| 200 74 1870 | REFEEDING | EVALUATION OF POULTRY MANURE AS A FEED INGREDIENT KEYWORDS POULTRY EXCRETA DRIED-POULT |
| 300 73 1874 | REFEEDING | RECYCLING ANIMAL WASTES AS PROTEIN SOURCES KEYWORDS RECYCLING ANIMAL-WASTES PROTEINS R |
| 600 72 1901 | REFEEDING | FACTORS WHICH INFLUENCE THE UTILIZATION OF ANIMAL EXCRETA EITHER DIRECTLY BY ANIMALS OR |
| 400 74 1906 | REFEEDING | PROCESSED MANURE SEEN AS PROTEIN OF FUTURE KEYWORDS CATTLE REFEEDING EXCRETA PROTEINS |
| 600 74 1916 | REFEEDING | COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE KEYWORDS RECYCLING POULTRY REFEEDING |
| 400 71 1935 | REFEEDING | BARN WASTES FOR FEED KEYWORDS FEEDS RUMINANTS BARN-WASTES REFEEDING DIGESTIBILITY CHE |
| 400 72 1939 | REFEEDING | WASTE CONVERSION UNIT DEVELOPED KEYWORDS FEEDS METHANE FERMENTATION ANAEROBIC-CONDITI |
| 400 72 1944 | REFEEDING | THE DOOR IS STILL OPEN TO REFEEDING CATTLE WASTE KEYWORDS CATTLE REGULATION PROTEINS |
| 400 72 1945 | REFEEDING | THIS PLANT WILL CONVERT WASTE INTO PROTEIN KEYWORDS FEEDS PROTEINS THERMOPHILIC-BACTE |
| 400 73 1946 | REFEEDING | RECOVER RECYCLE REUSE KEYWORDS FEEDS RECYCLING LIVESTOCK POULTRY FEEDLOTS CELLULOSE |
| 400 74 1955 | REFEEDING | FEEDING PELLETED DRIED POULTRY LITTER TO HOLSTEIN STEERS KEYWORDS FEEDS PERFORMANCE CA |
| 300 74 1959 | REFEEDING | ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES KEYWORDS RECYCLING ANIMAL- |
| 200 74 1989 | REFEEDING | RECYCLING ANIMAL WASTE AND BY PRODUCTS KEYWORDS RECYCLING CATTLE FEEDS ECONOMICS PER |
| 200 74 1996 | REFEEDING | PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE KEYWORDS REGULATION LEGAL-ASPECTS WAST |
| 200 74 2018 | REFEEDING | BEEF FEEDLOT WASTE IN RATIONS FOR BEEF CATTLE KEYWORDS CATTLE DIETS PERFORMANCE REFEED |
| 200 74 2022 | REFEEDING | BEEF OXIDATION DITCH SETTLED SOLIDS FED TO STEERS KEYWORDS FEEDS CATTLE SOLID-WASTES P |
| 200 74 2025 | REFEEDING | WASTE TREATMENT WITH A PROTEIN BONUS KEYWORDS AEROBIC-TREATMENT PROTEINS NITRIFICATIO |
| 400 75 2040 | REFEEDING | PROCESSED EXCRETA POTENTIALLY NUTRITIONAL KEYWORDS CATTLE FEEDS PROTEINS RECYCLING PE |
| 400 75 2049 | REFEEDING | MANURE ROUGHAGE SILAGE FOR RUMINANTS KEYWORDS SILAGE RUMINANTS NUTRIENTS FEEDS NITROG |
| 100 74 2057 | REFEEDING | ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT USE MANURE KEYWORDS |
| 400 73 2058 | REFEEDING | POULTRY WASTES STUDIED FOR USE IN LIVESTOCK FEED KEYWORDS FEEDS LIVESTOCK PERFORMANCE |
| 400 74 2065 | REFEEDING | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORDS IDAHO RECYCLIN |
| 400 73 2067 | REFEEDING | DRIED POULTRY MANURE UTILIZATION KEYWORDS RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO |
| 400 75 2071 | REFEEDING | DUNG HO-FDA SETS REGS ON RECYCLED FEED KEYWORDS REGULATION RECYCLING ANIMAL-WASTES FE |
| 300 2085 | REFEEDING | DAIRY WASTE MANAGEMENT ALTERNATIVES KEYWORDS LIQUID-WASTES SOLID-WASTES AGRICULTURAL- |
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| 200 | 73 | 2440 | RESEARCH-AND-DEVEL | REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS-ANNUAL REPORT OF COOPE |
| 200 | 74 | 2462 | RESEARCH-AND-DEVEL | PRODUCTION OF METHANE FROM POULTRY MANURE  KEYWORDS  METHANE RESEARCH-AND-DEVELOPMENT C |
| 300 | 75 | 2495 | RESEARCH-AND-DEVEL | RESEARCH STATUS ON EFFECTS OF LAND APPLICATION OF ANIMAL WASTES  KEYWORDS  SOIL-DISPOSA |
| 100 | 69 | 2562 | RESEARCH-AND-DEVEL | RESEARCH AND PRACTICE IN ANIMAL WASTES TREATMENT  KEYWORDS  ANIMAL-WASTES WASTE-TREATME |
| 100 | 73 | 2579 | RESEARCH-AND-DEVEL | MICROBIOLOGY IN THE AEROBIC TREATMENT OF FARM WASTES KEYWORDS  MICROBIOLOGY AEROBIC-TRE |
| 200 | 75 | 2653 | RESEARCH-AND-DEVEL | CONVERSION OF ANIMAL WASTES TO FEED SUPPLEMENTS VIA THE ORGANIFORM PROCESS  KEYWORDS  O |
| 200 | 75 | 2655 | RESEARCH-AND-DEVEL | START UP OF PILOT SCALE SWINE MANURE DIGESTERS FOR METHANE  KEYWORDS  RESEARCH-AND-DEVE |
| 200 | 75 | 2709 | RESEARCH-AND-DEVEL | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA  KEYWORDS  AGRIC |
| 200 | 75 | 2744 | RESEARCH-AND-DEVEL | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM  KEYWORDS  WASTE-TREATME |
| 100 | 72 | 2801 | RESEARCH-AND-DEVEL | RESEARCH AND TECHNOLOGY  KEYWORDS  RESEARCH-AND-DEVELOPMENT RECYCLING FEEDS FUELS METHA |
| 100 | 70 | 1823 | RESIDUES | GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE  KEYWORDS  FEEDS ADD |
| 400 | 72 | 2304 | RESIDUES | DATA NEEDED ON SAFETY OF RECYCLING WASTE  KEYWORDS  RECYCLING PATHOGENIC-BACTERIA SAFET |
| 600 | 72 | 1875 | RESISTANCE | AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS |
| 200 | 73 | 2101 | RESPIRATION | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS  KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 400 | 73 | 1854 | RESPIRATORY-DISEAS | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES  KEYWORDS  AMMONIA LITTER BROILERS V |
| 200 | 73 | 2101 | RESPIRATORY-TRACT | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS  KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 600 | 75 | 2537 | RETENTION-BASINSAN | MODEL TO PREDICT THE PERFORMANCE OF FEEDLOT CONTROL FACILITIES AT SPECIFIC OREGON LOCAT |
| 100 | 74 | 2408 | RETENTION-PONDS | REVIEW PAPER-ANIMAL WASTES MANAGEMENT AND CHARACTERIZATION  KEYWORDS  FARM-WASTES PHYSI |
| 400 | 70 | 2803 | RETENTION-PONDS | FEEDLOT POLLUTION-A SOLVABLE PROBLEM  KEYWORDS  AGRICULTURAL-RUNOFF WATER-POLLUTION SOU |
| 400 | 72 | 1742 | RETENTION-POND | THAT INESCAPABLE BYPRODUCT  KEYWORDS  DESIGN FEEDLOTS COLORADO RUNOFF-CONTROL LAND-DISP |
| 100 | 72 | 2799 | RETORT-SYSTEM | RETORTING FEEDLOT WASTES  KEYWORDS  FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO |
| 400 | 71 | 1985 | RETURN-FLOW | IRRIGATION RESIDUES  KEYWORDS  IRRIGATION-EFFECTS POLLUTANTS WATER-QUALITY-CONTROL WAST |
| 200 | 71 | 2453 | RETURN-FLOW | AGRICULTURAL WASTES IN ARID ZONES  KEYWORDS  AGRICULTURAL-WASTES DOMESTIC-WASTES WATER- |
| 300 | 73 | 1881 | REUSE | A RECIRCULATING WASTE SYSTEM FOR SWINE UNITS  KEYWORDS SWINE WASTE-TREATMENT  OXIDATION |
| 200 | 69 | 1980 | REUSE | THE REUSE OF OLD LITTER  KEYWORDS  LITTER POULTRY REUSE BUILT-UP-LITTER  MAREKS-DISEASE |
| 200 | 75 | 2747 | REVERSE-OSMOSIS | TERTIARY TREATMENT OF ANIMAL WASTEWATERS BY REVERSE OSMOSIS MEMBRANES  KEYWORDS  TERTIA |
| 700 | 72 | 2319 | RHIZOSPHERE | THE MICROBIAL ECOLOGY OF CULTIVATED SOIL RECEIVING COW MANURE WASTE  KEYWORDS  FARM-WAS |
| 200 | 75 | 2715 | RIDGE-AND-FURROW | EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL  KEYWORDS |
| 600 | 74 | 1846 | RISER-INTAKE-DESIG | RISER INTAKE DESIGNS FOR FEEDLOT SOLIDS COLLECTION BASINS KEYWORDS  FEEDLOTS SOLID-WAST |
| 400 | 71 | 2237 | RODENTS | COMPOSTING POULTRY MANURE IN DEEP PITS  KEYWORDS  COMPOSTING POULTRY WASTE-STORAGE ODOR |
| 400 | 71 | 2276 | RODENTS | THE FALLACY OF DEEP PITS FOR POULTRY HOUSES  KEYWORDS DESIGN VENTILATION NUTRIENTS COST |
| 200 | 75 | 2638 | ROMANIA | TWO-STAGE ACTIVATED SLUDGE TREATMENT OF EFFLUENT FROM INDUSTRIAL HOG BREEDING FARMS  KE |
| 100 | 73 | 2325 | RONNEL | FEEDING OF COUMAPHOS RONNEL AND RABON TO DAIRY COWS- LARVICIDAL ACTIVITY AGAINST HOUSE |
| 300 | 72 | 2063 | ROTARY-KILN | COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE  KEYWORDS  BURNING |
| 200 | 74 | 2024 | ROTATING-BIOLOGICA | TREATMENT OF BEEF WASTE BY A ROTATING BIOLOGICAL CONTACTOR  KEYWORDS  AEROBIC-TREATMENT |
| 200 | 75 | 2719 | ROTATING-CONICAL-S | A ROTATING CONICAL SCREEN SEPARATOR FOR LIQUID-SOLID SEPARATION OF BEEF WASTE  KEYWORDS |
| 100 | 74 | 1855 | ROTATING-FLIGHTED- | A ROTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER  KEYWORDS  SOLID-WAST |
| 200 | 75 | 2717 | ROTATING-FLIGHTED- | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK  WASTE MANAGEMENT  KEYWORDS |
| 600 | 68 | 1862 | ROTORS | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 600 | 68 | 1862 | ROTOR-AERATED-TANK | BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR AERATED LI |
| 300 | 72 | 2370 | ROUGHAGES | COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS |
| 400 | 73 | 1812 | ROUGHAGE | FEEDING VARIATIONS CAN AFFECT WASTE  KEYWORDS  FEEDS FEED-LOTS CONFINEMENT-PENS TEXAS C |

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| | | | | |
|---|---|---|---|---|
| 400 | 75 | 2049 | ROUGHAGE | MANURE ROUGHAGE SILAGE FOR RUMINANTS KEYWORDS SILAGE RUMINANTS NUTRIENTS FEEDS NITROG |
| 700 | 71 | 1864 | RUMEN | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 600 | 72 | 1709 | RUMEN-BACTERIA | NUTRIENT CHANGES IN POULTRY EXCRETA FERMENTED WITH RUMEN BACTERIA KEYWORDS NUTRIENTS |
| 100 | 74 | 1950 | RUMINAL-FLUID | EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS KEYWORD |
| 100 | 73 | 1637 | RUMINANTS | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 100 | 72 | 1788 | RUMINANTS | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 300 | 73 | 1856 | RUMINANTS | RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES KEYWORDS RUMINAN |
| 200 | 74 | 1869 | RUMINANTS | RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM KEYWORDS RECYCLING DRIED-P |
| 300 | 71 | 1903 | RUMINANTS | FEEDING VALUE OF ANIMAL WASTES KEYWORDS FEEDS RUMINANTS MANURE LITERATURE-REVIEW ALGA |
| 400 | 71 | 1935 | RUMINANTS | BARN WASTES FOR FEED KEYWORDS FEEDS RUMINANTS BARN-WASTES REFEEDING DIGESTIBILITY CHE |
| 400 | 75 | 2049 | RUMINANTS | MANURE ROUGHAGE SILAGE FOR RUMINANTS KEYWORDS SILAGE RUMINANTS NUTRIENTS FEEDS NITROG |
| 200 | 75 | 2737 | RUMINANT-WASTES | SLUDGE MANAGEMENT FOR ANAEROBIC DAIRY WASTE LAGOONS KEYWORDS SLUDGE ANAEROBIC-LAGOONS |
| 300 | 73 | 1785 | RUNOFF | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 200 | 70 | 1805 | RUNOFF | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 200 | 71 | 1963 | RUNOFF | SOURCES AND FATE OF AVAILABLE NITROGEN IN RURAL ECOSYSTEMS KEYWORDS NITROGEN NITRATES |
| 100 | 74 | 2109 | RUNOFF | CHARACTERISTICS AND COMPARATIVE MAGNITUDE OF NONPOINT SOURCES KEYWORDS PRECIPITATION- |
| 400 | 72 | 2167 | RUNOFF | PLANNING FEEDLOT WASTE DISPOSAL KEYWORDS PLANNING FEEDLOTS WASTE-DISPOSAL WASTE-STORA |
| 700 | 74 | 2405 | RUNOFF | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 400 | 73 | 2504 | RUNOFF | STRIP MINE FEEDLOTS KEYWORDS STRIP-MINES FEEDLOTS CATTLE PERFORMANCE RUNOFF OHIO WAS |
| 100 | 74 | 2585 | RUNOFF | POLLUTION EFFECTS ON SURFACE AND GROUND WATERS KEYWORDS WATER-POLLUTION-SOURCES NUTRIE |
| 400 | 74 | 2773 | RUNOFF | THE EDITORS NOTEBOOK-ABOUT DISCHARGE REGULATIONS KEYWORDS CATFISHES RUNOFF PERMITS EN |
| 400 | 73 | 1820 | RUNOFF-CONTROL | GRASS FILTER SYSTEMS ANOTHER NEW RUNOFF CONTROL METHOD KEYWORDS WASTE-TREATMENT WASTE- |
| 400 | 72 | 1942 | RUNOFF-CONTROL | THAT INESCAPABLE BYPRODUCT KEYWORDS DESIGN FEEDLOTS COLORADO RUNOFF-CONTROL LAND-DISP |
| 100 | 74 | 1956 | RUNOFF-CONTROL | DISPOSAL OF EFFLUENT FROM A BEEF CATTLE FEEDLOT RUNOFF CONTROL HOLDING POND KEYWORDS |
| 200 | 71 | 1971 | RUNOFF-CONTROL | CONTROLLING BARNYARD RUNOFF KEYWORDS WASTE-DISPOSAL WISCONSIN FEEDLOTS RUNOFF-CONTROL |
| 200 | 71 | 1978 | RUNOFF-CONTROL | LARGE COMMERCIAL FEEDLOTS HOW WASTES ARE HANDLED IN THE WEST KEYWORDS FEEDLOTS NEBRASK |
| 200 | 74 | 2001 | RUNOFF-CONTROL | COST OF REDUCING SURFACE WATER POLLUTION FROM U S DAIRY FARMS KEYWORDS COSTS WATER-P |
| 200 | 74 | 2012 | RUNOFF-CONTROL | BEEF WASTE MANAGEMENT ECONOMICS FOR MINNESOTA FARMER FEEDERS KEYWORDS MINNESOTA REGUL |
| 400 | 74 | 2114 | RUNOFF-CONTROL | CONTROLLING MANURE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS SLURRIES LIQUID-WASTE |
| 600 | 73 | 2124 | RUNOFF-CONTROL | DESIGN AND OPERATION OF A FEEDLOT RUNOFF DISPOSAL SYSTEM-A CASE STUDY KEYWORDS DESIG |
| 200 | 74 | 2136 | RUNOFF-CONTROL | ANIMAL WASTE SYSTEMS KEYWORDS FEEDLOTS CONFINEMENT-PENS MICHIGAN WASTE-STORAGE WASTE- |
| 400 | 72 | 2210 | RUNOFF-CONTROL | STEP BY STEP PLAN FOR LIVESTOCK WASTE CONTROL KEYWORDS LIVESTOCK IOWA FEEDLOTS REGULAT |
| 400 | 71 | 2270 | RUNOFF-CONTROL | BRAKING FEEDLOT RUNOFF KEYWORDS RUNOFF-CONTROL FEEDLOTS NEBRASKA WATER-POLLUTION GROU |
| 400 | 72 | 2283 | RUNOFF-CONTROL | COSTS OF CONTROLLING FEEDLOT SURFACE RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF COST |
| 300 | 75 | 2335 | RUNOFF-CONTROL | ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES KEYWORDS LEGAL-ASPECTS REGULATION DAIR |
| 600 | 71 | 2531 | RUNOFF-CONTROL | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEEDLOTS DESIGN-CRITERIA MONTANA ENGINE |
| 200 | 75 | 2608 | RUNOFF-CONTROL | CONTROL COLLECTION AND DISPOSAL OF FEEDLOT RUNOFF KEYWORDS REGULATION ENGINEERING DES |
| 200 | 75 | 2610 | RUNOFF-CONTROL | AN ILLINOIS FEEDLOT RUNOFF CONTROL PROJECT KEYWORDS ILLINOIS FEEDLOTS DESIGN SPRINKLE |
| 200 | 75 | 2709 | RUNOFF-CONTROL | RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA KEYWORDS AGRIC |
| 200 | 75 | 2710 | RUNOFF-CONTROL | DESIGN RUNOFF VOLUME FROM FEEDLOTS IN THE SOUTHWESTERN GREAT PLAINS KEYWORDS DESIGN A |
| 300 | 74 | 1750 | RUNOFF-LOSSES | DESIGN PARAMETERS FOR ANIMAL WASTE TREATMENT SYSTEMS KEYWORDS LIQUID-AERATION-SYSTEMS |
| 200 | 75 | 2706 | RUNOFF-QUALITY | ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS KEYWORDS AGRICUL |
| 200 | 75 | 2711 | RUNOFF-QUALITY | QUANTITY AND QUALITY OF BEEF FEEDYARD RUNOFF IN THE GREAT PLAINS KEYWORDS AGRICULTURA |
| 200 | 75 | 2706 | RUNOFF-QUANTITY | ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS KEYWORDS AGRICUL |
| 200 | 75 | 2711 | RUNOFF-QUANTITY | QUANTITY AND QUALITY OF BEEF FEEDYARD RUNOFF IN THE GREAT PLAINS KEYWORDS AGRICULTURA |
| 200 | 71 | 1963 | RURAL-AREAS | SOURCES AND FATE OF AVAILABLE NITROGEN IN RURAL ECOSYSTEMS KEYWORDS NITROGEN NITRATES |
| 400 | 75 | 2120 | RURAL-ECONOMIC-ASS | THE HIGH COST OF RUNOFF CONTROLS-IS HELP NEEDED KEYWORDS COSTS AGRICULTURAL-RUNOFF CON |
| 100 | 75 | 2952 | RYE | DAIRY CATTLE MANURE-ITS EFFECT ON RYE AND MILLET FORAGE YIELD AND QUALITY KEYWORDS DA |
| 700 | 73 | 2792 | RYE | THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE KE |
| 400 | 73 | 2050 | SAFETY | POULTRY WASTES STUDIED FOR USE IN LIVESTOCK FEED KEYWORDS FEEDS LIVESTOCK PERFORMANCE |
| 400 | 72 | 2304 | SAFETY | DATA NEEDED ON SAFETY OF RECYCLING WASTE KEYWORDS RECYCLING PATHOGENIC-BACTERIA SAFET |
| 200 | 74 | 2468 | SAFETY | RECYCLING ITS PROBLEMS AND OPPORTUNITIES KEYWORDS RECYCLING METHANE LAGOONS NUTRIENTS |
| 400 | 75 | 2341 | SAFETY-FACTOR | MOST FLUME FLOORS SHORT ON ENGINEERING KEYWORDS SAFETY-FACTOR FLOW-RATE WASTE-DILUTIO |
| 400 | 72 | 1938 | SAGEBRUSH | SAGEBRUSH FOR ODOR CONTROL-IN THE FEED OR THE MANURE KEYWORDS SAGEBRUSH FEEDS PERFORMA |
| 200 | 72 | 1880 | SALINE-WASTE-WATER | EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES |
| 300 | 74 | 2576 | SALINE-WATER-INTRU | POLLUTED GROUNDWATER-A REVIEW OF THE SIGNIFICANT LITERATURE KEYWORDS GROUNDWATER-POLL |
| 900 | 73 | 1745 | SALINITY | GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS KEYWORDS FEEDLOTS MANURE CATTLE |
| 600 | 73 | 1813 | SALINITY | EXPERIENCE WITH A SPRAY RUNOFF SYSTEM FOR TREATING BEEF CATTLE FEEDLOT RUNOFF KEYWORDS |
| 100 | 73 | 2113 | SALINITY | EFFECTS OF APPLICATION RATE IN DIRECT LAND DISPOSAL OF ANIMAL WASTES KEYWORDS EFFECTS |
| 900 | | 2117 | SALINITY | FEEDLOT RUNOFF DISPOSAL ON GRASS OR CROPS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF IRRIG |
| 900 | 75 | 2339 | SALINITY | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 700 | 72 | 2390 | SALINITY | CATTLE FEEDLOT WASTEWATER SALINITY KEYWORDS FEEDLOTS CATTLE WASTE-WATER-POLLUTION SAL |
| 700 | 72 | 2569 | SALINITY | RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFF |
| 600 | 71 | 1985 | SALINITY-CONTROL | IRRIGATION RESIDUES KEYWORDS IRRIGATION-EFFECTS POLLUTANTS WATER-QUALITY-CONTROL WAST |
| 200 | 75 | 2587 | SALMONELLAE | SURVIVAL OF SALMONELLAE TOTAL COLIFORMS AND FECAL COLIFORMS IN SWINE WASTE LAGOON EFFLU |
| 100 | 73 | 1609 | SALMONELLA | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 100 | 73 | 1820 | SALMONELLA | THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID |
| 900 | 68 | 1940 | SALMONELLA | THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25 PER CENT GROUND BEEF MAN |
| 100 | 74 | 2327 | SALMONELLA | PERSISTENCE OF SALMONELLAE IN POULTRY EXCRETA KEYWORDS POULTRY SALMONELLA WASTE-STORAG |
| 100 | 75 | 2369 | SALMONELLA | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS EF |
| 200 | 75 | 2654 | SALMONELLA | HEALTH ASPECTS OF FEEDING ANIMAL WASTE CONSERVED IN SILAGE KEYWORDS PERFORMANCE SALMON |
| 200 | 75 | 2684 | SALMONELLA | SWINE WASTE LAGOONS AS POTENTIAL DISEASE RESERVOIRS KEYWORDS LAGOONS DISEASES PATHOGE |
| 100 | 71 | 2767 | SALMONELLA | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 100 | 72 | 2789 | SALMONELLA | EFFLUENT SPRAY DISEASE RISK KEYWORDS HEALTH DISEASES SALMONELLA SPRAY-IRRIGATION CATT |
| 200 | 74 | 2000 | SALMONELLA-TYPHIMU | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 900 | 73 | 2304 | SALMONELLA-TYPHIMU | SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS |
| 600 | 72 | 2594 | SALMONELLOSIS | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 600 | 74 | 1796 | SALTS | ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN |
| 900 | | 1767 | SALTS | MANURE WASTE PONDING STUDY KEYWORDS GROUNDWATER-POLLUTION NITRATES HOLDING-PONDS MANU |
| 100 | 74 | 1821 | SALTS | IRRIGATION OF PERENNIAL FORAGE CROPS WITH FEEDLOT RUNOFF KEYWORDS IRRIGATION AGRICULTU |
| 600 | 71 | 1899 | SALTS | NITROGEN LOAD OF SOIL IN GROUND WATER FROM DAIRY MANURE KEYWORDS NITROGEN-COMPOUNDS DA |
| 100 | 71 | 1910 | SALTS | SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM KEYWORDS SALTS RECYC |
| 200 | 74 | 2032 | SALTS | EFFECT OF LIQUID SWINE WASTE APPLICATION ON SOIL CHEMICAL COMPOSITION KEYWORDS LIQUID |
| 200 | 74 | 2033 | SALTS | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 200 | 74 | 2034 | SALTS | SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES KEYWORDS DAIRY-INDUSTRY SOIL |
| 100 | 74 | 2082 | SALTS | WASTE ACCUMULATION ON A SELECTED DAIRY CORRAL AND ITS EFFECT ON THE NITRATE AND SALT OF |
| 600 | 74 | 2093 | SALTS | COMPOSTED CHICKEN LITTER SEEMS TO RECLAIM SALT DAMAGED LAND KEYWORDS SALTS RECLAMATIO |
| 200 | 74 | 2104 | SALTS | EFFECT OF HOUSING TYPE ON NUTRIENT COMPOSITION OF BEEF CATTLE MANURE KEYWORDS HOUSING |
| 600 | 72 | 2224 | SALTS | DAIRY WASTE GOES FULL CYCLE IN RESEARCH KEYWORDS DAIRY-INDUSTRY LAND-DISPOSAL LIQUID- |
| 100 | 72 | 2292 | SALTS | MANURE HOLDING PONDS FOUND SELFSEALING KEYWORDS WASTE-STORAGE WATER-POLLUTION POULTRY |
| 900 | 72 | 2376 | SALTS | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 200 | 75 | 2442 | SALTS | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES LI |
| 200 | 75 | 2449 | SALTS | AGRONOMIC CONSIDERATIONS OF ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL AGRONOMY CR |
| 600 | 75 | 2597 | SALTS | LAND AND CROP UTILIZATION OF ANIMAL MANURE AT FIVE MINNESOTA LOCATIONS KEYWORDS MINNE |
| 200 | 75 | 2623 | SALTS | A PLANNING STUDY ON DAIRY WASTES MANAGEMENT KEYWORDS DAIRY-INDUSTRY CALIFORNIA WATER-P |
| 200 | 75 | 2680 | SALTS | RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE ON GRAIN SORGHUM YIELDS KEYWORDS FERTILIZE |
| 200 | 75 | 2683 | SALTS | DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND KEYWORDS FEEDLOTS CATTLE KANSAS CROP-RESPONS |
| 200 | 75 | 2685 | SALTS | EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TO VARIATIONS IN CONCENTRATIONS OF SOD |
| 200 | 75 | 2688 | SALTS | CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE KEYWORD |
| 600 | 75 | 2045 | SALT | GUIDELINES FOR LAND DISPOSAL OF FEEDLOT LAGOON WATER KEYWORDS FEEDLOTS LAGOONS KANSAS |

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|---|---|---|---|---|
| 400 | 72 | 2366 | SALT-BUILDUP | SWINE MANURE LAND APPLICATION RATES KEYWORDS WASTE-DISPOSAL NITROGEN INDIANA WATER-PO |
| 100 | 73 | 2121 | SALT-INJURY | EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTE |
| 100 | 74 | 2236 | SALT-POLLUTED-SOIL | USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS KEYWORDS RECLAMATION POUL |
| 200 | 73 | 2486 | SALT-TOLERANCE | SUMMARY OF KANSAS EXPERIENCE WITH LIQUID WASTE SPREADING KEYWORDS KANSAS AGRICULTURAL- |
| 300 | 74 | 1619 | SAMPLING | FERTILIZER VALUE OF DAIRY LOT MANURE KEYWORDS FERTILIZERS DAIRY-INDUSTRY CONFINEMENT- |
| 300 | 74 | 1629 | SAMPLING | CONTROL OF DUST FROM CATTLE FEEDLOTS KEYWORDS CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN |
| 200 | 68 | 1642 | SAMPLING | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 700 | 69 | 1650 | SAMPLING | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN-D |
| 100 | 73 | 1660 | SAMPLING | FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAM |
| 100 | 73 | 1664 | SAMPLING | A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF BED |
| 700 | 71 | 1665 | SAMPLING | MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM WASTE LAGOON KEYWORDS FAR |
| 700 | 71 | 1668 | SAMPLING | NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE KEYWORDS NITR |
| 700 | 69 | 1708 | SAMPLING | SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT KEYWORDS SOILS P |
| 400 | 73 | 1740 | SAMPLING | RUNOFF CONTROL SYSTEMS FOR CONCRETE DAIRY CATTLE YARDS KEYWORDS CATTLE DAIRY-INDUSTRY |
| 600 | 74 | 1751 | SAMPLING | CHEMICAL CHANGES IN SOILS USED FOR BEEF MANURE DISPOSAL KEYWORDS CATTLE WASTE-DISPOSAL |
| 100 | 73 | 1755 | SAMPLING | AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES KEYWORDS SAMPLING SOILS NI |
| 100 | 72 | 1788 | SAMPLING | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 200 | 73 | 1789 | SAMPLING | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
| 100 | 73 | 1832 | SAMPLING | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 200 | 69 | 1840 | SAMPLING | PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT KEYWORDS DRIED-POULTRY-WASTE R |
| 600 | 69 | 1841 | SAMPLING | A PROCEDURE TO IDENTIFY MALODORS FROM ANIMAL WASTES KEYWORDS ODOR GAS-CHROMATOGRAPHY S |
| 700 | 71 | 1864 | SAMPLING | KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTR |
| 400 | 71 | 1899 | SAMPLING | NITROGEN LOAD OF SOIL IN GROUND WATER FROM DAIRY MANURE KEYWORDS NITROGEN-COMPOUNDS DA |
| 100 | 74 | 1956 | SAMPLING | DISPOSAL OF EFFLUENT FROM A BEEF CATTLE FEEDLOT RUNOFF CONTROL HOLDING POND KEYWORDS |
| 400 | 73 | 1957 | SAMPLING | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 600 | 74 | 2068 | SAMPLING | EFFECT OF A LIVESTOCK WINTERING OPERATION ON A WESTERN MOUNTAIN STREAM KEYWORDS STREA |
| 700 | 72 | 2127 | SAMPLING | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 200 | 64 | 2182 | SAMPLING | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N |
| 700 | 65 | 2188 | SAMPLING | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 300 | 73 | 2208 | SAMPLING | USE OF CATTLE FEEDLOT RUNOFF IN CROP PRODUCTION KEYWORDS FEEDLOTS CATTLE AGRICULTURAL- |
| 400 | 72 | 2211 | SAMPLING | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING BA |
| 400 | 72 | 2211 | SAMPLING | TEST WAYS TO REDUCE FEEDLOT POLLUTION KEYWORDS FEEDLOTS SLOPES MANAGEMENT SAMPLING BA |
| 100 | 73 | 2218 | SAMPLING | DESIGN OF SOLID MANURE STORAGE FOR DAIRY HERDS KEYWORDS DESIGN WASTE-STORAGE SOLID-WAS |
| 300 | 68 | 2220 | SAMPLING | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 700 | 70 | 2229 | SAMPLING | DEVELOPMENT OF A NITROGEN BALANCE IN A LABORATORY SOIL PROFILE WITH A HEAVY APPLICATION |
| 400 | 71 | 2270 | SAMPLING | BRAKING FEEDLOT RUNOFF KEYWORDS RUNOFF-CONTROL FEEDLOTS NEBRASKA WATER-POLLUTION GROU |
| 300 | 71 | 2286 | SAMPLING | IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS KEYWORDS ODOR MEASUREMENT FEEDLOTS CATTLE |
| 100 | 75 | 2365 | SAMPLING | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS EF |
| 700 | 72 | 2390 | SAMPLING | CATTLE FEEDLOT WASTEWATER SALINITY KEYWORDS FEEDLOTS CATTLE WASTE-WATER-POLLUTION SAL |
| 100 | 71 | 2424 | SAMPLING | VOLATILIZATION OF NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS KEYWORDS FEEDL |
| 100 | 74 | 2430 | SAMPLING | ODOR REDUCTION FOR LIQUID MANURE SYSTEMS KEYWORDS ODOR MEASUREMENT LIQUID-WASTES INJE |
| 100 | 74 | 2502 | SAMPLING | A SURVEY OF EFFECTS OF ANIMAL WASTES ON STREAM POLLUTION FROM SELECTED DAIRY FARMS KEY |
| 700 | 63 | 2553 | SAMPLING | THE USE OF INDOOR LAGOONS FOR MANURE DISPOSAL IN HIGH DENSITY SYSTEMS OF POULTRY MANAGE |
| 700 | 74 | 2564 | SAMPLING | PHYSICAL CHARACTERISTICS OF THE SURFACE AND INTERFACE LAYERS OF A LEVEL BEEF CATTLE FEE |
| 100 | 73 | 2579 | SAMPLING | MICROBIOLOGY IN THE AEROBIC TREATMENT OF FARM WASTES KEYWORDS MICROBIOLOGY AEROBIC-TRE |
| 200 | 75 | 2586 | SAMPLING | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS BA |
| 200 | 75 | 2670 | SAMPLING | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORDS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2673 | SAMPLING | ANIMAL WASTE CONTRIBUTION TO NITRATE NITROGEN IN SOIL KEYWORDS LIQUID-WASTES DAIRY-IND |
| 200 | 75 | 2675 | SAMPLING | EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS KEY |
| 200 | 75 | 2754 | SAMPLING | POLLUTION ABATEMENT OF POULTRY MANURE BY MAXI-MIXING METHOD KEYWORDS POULTRY COSTS WAS |
| 100 | 71 | 2767 | SAMPLING | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 700 | 64 | 2768 | SAMPLING | CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING KEYWORDS PHYSICAL-PROPERT |
| 700 | 70 | 2781 | SAMPLING | AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS KEYWOR |
| 100 | 71 | 2806 | SAMPLING | AN ECOLOGICAL BLUEPRINT FOR TODAY KEYWORDS WASTE-DISPOSAL SAMPLING CHEMICAL-PROPERTIE |
| 700 | 72 | 2127 | SANDS | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 700 | 74 | 2405 | SANDS | SOIL ABSORPTION OF HUMIC COLOR KEYWORDS COLOR FEEDLOTS ABSORPTION CHEMICAL-OXYGEN-DEM |
| 600 | 74 | 1845 | SANDY-LOAM | ANIMAL WASTE AND NITRATE MOVEMENT THROUGH SOIL KEYWORDS ANIMAL-WASTES GROUNDWATER-POLL |
| 600 | 66 | 2194 | SAND-BED-FILTER | TREATMENT OF LIQUID HOG MANURE TO SUPPRESS ODORS KEYWORDS WASTE-TREATMENT LIQUID-WAST |
| 300 | 73 | 1785 | SANITARY-ENGINEERI | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 300 | 73 | 1785 | SANITARY-LANDFILL- | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 200 | 63 | 2164 | SANITARY-LANDFILL- | SANITARY LANDFILLING OF POULTRY WASTES KEYWORDS POULTRY SOLID-WASTES COSTS MANURE SAN |
| 200 | 73 | 2433 | SANITARY-WATER-BOA | STATUS OF THE ILLINOIS LIVESTOCK WASTE MANAGEMENT REGULATIONS KEYWORDS ILLINOIS LEGAL |
| 400 | 74 | 1810 | SANITATION | NO CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 300 | 72 | 2268 | SANITATION | FLY CONTROL ON POULTRY FARMS KEYWORDS INSECTICIDES FLY-CONTROL SANITATION OPEN-FLOOR- |
| 300 | 75 | 2335 | SANITATION | ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES KEYWORDS LEGAL-ASPECTS REGULATION DAIR |
| 600 | 73 | 2574 | SANITATION-REQUIRE | METHODS AND PROBLEMS RELATING TO DISPOSAL OF WASTES FROM LIVESTOCK MARKETS KEYWORDS W |
| 300 | 71 | 1865 | SAWDUST | ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL KEYWORDS POULTRY NITROGEN CARBON A |
| 200 | 70 | 2391 | SAWDUST | REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION KEYWORDS RE |
| 300 | 75 | 2545 | SCAVENGERS | INTEGRATED FLY CONTROL ON POULTRY RANCHES KEYWORDS PREDATORS SCAVENGERS POULTRY CALIFO |
| 200 | 73 | 1648 | SCENTOMETER | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 200 | 75 | 2691 | SCENTOMETER | EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS KEYWORDS FEED |
| 700 | 68 | 1837 | SCOTLAND | A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM A |
| 100 | 72 | 2580 | SCOTLAND | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE |
| 200 | 75 | 2740 | SCOTLAND | BIOENGINEERING ASPECTS OF ANAEROBIC DIGESTION OF PIGGERY WASTES KEYWORDS ANAEROBIC-DI |
| 200 | 75 | 2742 | SCOTLAND | AEROBIC TREATMENT OF PIGGERY WASTE PRIOR TO LAND TREATMENT-A CASE STUDY KEYWORDS AERO |
| 200 | 75 | 2743 | SCOTLAND | BIOLOGICALLY-CONTROLLED LOADING OF AEROBIC STABILIZATION PLANTS KEYWORDS DESIGN-CRITE |
| 300 | 74 | 2791 | SCOTLAND | THE TREATMENT OF PIGGERY WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL SWINE SCOTLA |
| 400 | 64 | 2793 | SCOURS | CHICKEN LITTER COW FEED KEYWORDS FEEDS LITTERS POULTRY CATTLE MAINE PERFORMANCE COSTS |
| 200 | 74 | 2464 | SCRAPERS | OUR DEEP PIT SYSTEM KEYWORDS CONFINEMENT-PENS COSTS CATTLE LAGOONS WATER-POLLUTION-CO |
| 700 | 71 | 1689 | SCREENING | THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE |
| 200 | 73 | 2478 | SCREENING | SOLIDS SEPARATION KEYWORDS SEPARATION-TECHNIQUES SOLID-WASTES SLURRIES SETTLING-BASIN |
| 600 | 72 | 1993 | SCREENS | STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES KEYWORD |
| 100 | 74 | 2449 | SCREENS | ENHANCED TREATMENT OF LIVESTOCK WASTEWATER I SOLID LIQUID SEPARATION-ESTIMATION OF VIBR |
| 200 | 75 | 2720 | SCREENS | EVALUATION OF SOLIDS SEPARATION DEVICES KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN |
| 200 | 75 | 2714 | SCREW-CONVEYORS | PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS KEYWORDS E |
| 100 | 73 | 1773 | SCREW-PRESS | DAIRY CATTLE MANURE LIQUID SOLID SEPARATION WITH A SCREW PRESS KEYWORDS DAIRY-INDUSTR |
| 100 | 71 | 2767 | SEAGULL | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 200 | 74 | 2033 | SEALING | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 700 | 72 | 2127 | SEALING | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 100 | 71 | 2767 | SEASHORES | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 100 | 72 | 2110 | SEAWATER | TOXICITY OF SEAWATER TO COLIFORM BACTERIA KEYWORDS TOXICITY SEAWATER COLIFORMS BACTER |
| 100 | 73 | 1832 | SEA-WATER | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 200 | 68 | 1642 | SEDIMENTATION | EGG LAYING HOUSE WASTES KEYWORDS EXCRETA WASTE-MANAGEMENT POULTRY DRYING ANAEROBIC-DI |
| 300 | 73 | 1915 | SEDIMENTATION | METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURC |
| 200 | 75 | 2717 | SEDIMENTATION | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 200 | 75 | 2718 | SEDIMENTATION | SETTLING CHARACTERISTICS OF SWINE MANURE AS RELATED TO DIGESTER LOADING KEYWORDS SEPA |
| 200 | 75 | 2676 | SEDIMENTS | NUTRIENT CHARACTERISTICS OF WASTES FROM DEEP PITS AND ANAEROBIC LAGOONS KEYWORDS LAGO |
| 200 | 75 | 2679 | SEDIMENTS | BACTERIAL ANALYSIS AND LAND DISPOSAL OF FARM WASTE LAGOON WATERS KEYWORDS LAGOONS BAC |
| 300 | 72 | 1658 | SEDIMENT-CONTROL | CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM AGRICULTURAL LANDS KEYWORDS SEDIMENT-C |
| 400 | 75 | 2508 | SEDIMENT-MANAGEMEN | EMERGING ISSUES IN FEEDLOT WASTE MANAGEMENT KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF RECY |

# KEYWORD INDEX

| | | | | |
|---|---|---|---|---|
| 200 | 74 | 2011 | SEDIMENT-TRANSPORT | LANC DISPOSAL PARAMETERS FOR DAIRY MANURE KEYWCRDS DAIRY-INDUSTRY NUTRIENTS SEDIMENT- |
| 100 | 73 | 1685 | SEECING | SURVIVAL OF SALMONELLA TYPHIMLRIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 70C | 74 | 2765 | SEECLING-DEVELOPME | ANIMAL WASTES-PHYTOTOXIC EFFECTS ON PLANT GROWTH-INFLUENCE ON THE FEEDLOT SOIL PROFILE |
| 30C | 74 | 1860 | SEEPAGE | ESTIMATING NUTRIENT LOADINGS CF LAKES FROM NCNPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 200 | 71 | 1931 | SEEPAGE | EFFECT OF CATTLE FEEDLOT WASTES UPON GROUND WATER-A COMMENTARY KEYWORDS FEEDLOTS GROU |
| 2CC | 74 | 2033 | SEEPAGE | MANURE HOLDING POND SEALING STUDY KEYWORDS SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO |
| 100 | 74 | 2109 | SEEPAGE | CHARACTERISTICS AND CCMPARATIVE MAGNITUDE OF NONPOINT SOURCES KEYWORDS PRECIPITATION- |
| 700 | 72 | 2127 | SEEPAGE | SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANCY HIGH WATER TABLE SOILS KEYWORDS SOI |
| 600 | 72 | 2195 | SEEPAGE | ROOFED VS UNROOFED SOLID MANURE STORAGES FOR DAIRY CATTLE KEYWORDS WASTE-STORAGE DAIRY- |
| 100 | 73 | 2218 | SEEPAGE | DESIGN OF SOLID MANURE STORAGE FOR DAIRY HERDS KEYWORDS DESIGN WASTE-STORAGE SOLID-WAS |
| 200 | 73 | 2434 | SEEPAGE | STORAGE STRUCTURES FOR SOLID MANURE KEYWORDS WASTE-STORAGE SOLID-WASTES SEPARATION-TE |
| 200 | 75 | 2670 | SEEPAGE | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORCS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2671 | SEEPAGE | SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN |
| 200 | 71 | 1930 | SEEPAGE-CONTROL | SEEPAGE LOSS FROM HOLDING PONDS KEYWCRDS SEEPAGE-CONTROL PERMEABILITY HOLDING-PONDS |
| 200 | 73 | 2441 | SELECTION-CRITERIA | SELECTION OF PUMPS PIPING AND WASTE CISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 30C | 72 | 2292 | SELF-SEALING | MANURE HOLDING PCNDS FOUND SELFSEALING KEYWCRDS WASTE-STORAGE WATER-POLLUTION POULTRY |
| 100 | 73 | 1660 | SEMIARID-CLIMATES | FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZEC AS AN ASSESSMENT OF AGRICULTURAL CONTAM |
| 100 | 75 | 2410 | SEMI-BATCH-PROCESS | SOLIDS REDUCTICN CF BEEF CATTLE WASTES IN A SEMIBATCH PROCESS OXICATION DITCH KEYWORDS |
| 200 | 63 | 2159 | SEMI-LIQUIC-WASTES | PROGRESS REPORT ON MANURE HARVESTING KEYWORDS PCULTRY LIQUID-WASTES WASTE-STORAGE WAS |
| 300 | 74 | 2215 | SEMI-SOLID-WASTES | A COMPARISCN OF SOLID AND LIQUID MANURE STORAGE SYSTEMS KEYWORDS WASTE-STORAGE SCLID-W |
| 100 | 74 | 1894 | SENSIBLE-HEAT | HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS KEYWORDS DES |
| 600 | 72 | 1993 | SEPARATION | STATIONARY SLOPING SCREEN TC SEPARATE SCLIDS FRCM CAIRY CATTLE MANURE SLURRIES KEYWORD |
| 400 | 75 | 2344 | SEPARATION | SEPARATING SOLID WASTE FROM LIQUID KEYWORDS SOLID-WASTES LIQUID-WASTES CATTLE RECYCL |
| 200 | 75 | 2641 | SEPARATION | RECCVERY OF NUTRIENTS FROM ANIMAL WASTES-AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS |
| 600 | 71 | 1718 | SEPARATICN-TECHNIQ | SYSTEM COMPONENTS TO SEPARATE SCLIDS ANC LIQUIDS KEYWORDS SOLID-WASTES LIQUID-WASTES |
| 600 | 74 | 1847 | SEPARATION-TECHNIQ | CABLE CRIVEN SCRAPERS FCR MANURE CCLLECTICN ANC LIQUIC SOLID SEPARATION KEYWORDS LIQU |
| 100 | 74 | 1855 | SEPARATION-TECHNIC | A ROTATING FLIGHTED CYLINCER TO SEPARATE MANURE SOLIDS FROM WATER KEYWORDS SOLID-WAST |
| 40C | 75 | 2056 | SEPARATION-TECHNIC | MILK PLUS MANURE-HIGHER DAIRY PROFITS KEYWORDS SEPARATION-TECHNIQUES DAIRY-INDUSTRY L |
| 400 | 74 | 2065 | SEPARATION-TECHNIQ | IDAHO FEEDER ENDS MANURE WORRY-ADOPTS TOTAL RECYCLING SYSTEMS KEYWORUS IDAHO RECYCLIN |
| 600 | 72 | 2074 | SEPARATION-TECHNIC | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE |
| 100 | 74 | 2097 | SEPARATION-TECHNIC | SIZE DISTRIBUTION AND NUTRITIONAL VALUE OF SWINE MANURF SEPARATES KEYWORDS NUTRIENTS |
| 600 | 72 | 2262 | SEPARATION-TECHNIQ | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR |
| 400 | 72 | 2290 | SEPARATION-TECHNIQ | NEW WASTE TREATMENT SYSTEM IS USED FCR HOGS KEYWORCS WASTE-TREATMENT SEPARATION-TECHNI |
| 700 | 72 | 2316 | SEPARATION-TECHNIC | LIQUID-SOLID SEPARATION CF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 200 | 73 | 2434 | SEPARATICN-TECHNIC | STORAGE STRUCTURES FOR SOLID MANURE KEYWORDS WASTE-STORAGE SOLID-WASTES SEPARATION-TE |
| 1U0 | 74 | 2449 | SEPARATION-TECHNIC | ENHANCEC TREATMENT OF LIVESTOCK WASTEWATER I SOLIC LIQUID SEPARATION-ESTIMATION OF VIBR |
| 200 | 73 | 2472 | SEPARATION-TECHNIQ | MIDWEST LIVESTOCK WASTE MANAGEMENT CCNFERENCE KEYWORDS FEEDLOTS HYDROLOGY DESIGN CONFI |
| 20C | 73 | 2478 | SEPARATION-TECHNIC | SOLIDS SEPARATION KEYWCRCS SEPARATICN-TECHNIQUES SCLID-WASTES SLURRIES SETTLING-BASIN |
| 100 | 74 | 2541 | SEPARATICN-TECHNIC | RECCVERING PROTEIN FROM DAIRY CATTLE WASTES KEYWCRCS PROTEINS CAIRY-INDUSTRY SEPARATIO |
| 200 | 75 | 2617 | SEPARATION-TECHNIQ | WASTE MANAGEMENT AT HALL BRCTHERS DAIRY KEYWURDS DAIRY-INDUSTRY CONFINEMENT-PENS SEPAR |
| 200 | 75 | 2624 | SEPARATICN-TECHNIC | DAIRY WASTE FIBER-A BYPRODUCT WITH A FUTURE KEYWCRCS CAIRY-INDUSTRY SEPARATION-TECHNIQ |
| 200 | 75 | 2639 | SEPARATICN-TECHNIC | A PIG SLURRY TREATMENT SYSTEM BASED CN SEPARATICN BEFORE AEROBIC TREATMENT AND SLUDGE D |
| 200 | 75 | 2686 | SEPARATION-TECHNIC | PARTICLE SIZE DISTRIBUTICN CF LIVESTCCK WASTES KEYWORCS SEPARATION-TECHNIQUES FEEDS VA |
| 20C | 75 | 2700 | SEPARATION-TECHNIC | IF YOU CANNOT SPREAC IT TREAT IT KEYWORDS SLURRIES WASTE-TREATMENT SEPARATION-TECHNIQ |
| 200 | 75 | 2701 | SEPARATION-TECHNIQ | EVAPORATION CF WATER FROM HCLDING PONDS KEYWORDS EVAPORATION PHYSICAL-PROPERTIES CHEM |
| 200 | 75 | 2704 | SEPARATION-TECHNIC | FIELD EVALUATICN CF A SETTLING CHAMBER FOR SWINE WASTES KEYWORDS SEPARATICN-TECHNIQUES |
| 20C | 75 | 2712 | SEPARATICN-TECHNIC | PROPERTIES OF SOLICS AND LIQUIDS FROM STACKEC MANURE KEYWORDS SCLID-WASTES LIQUID-WAST |
| 20C | 75 | 2717 | SEPARATION-TECHNIQ | APPLICATION OF THE RCTATING FLIGHTED CYLINDER TC LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 200 | 75 | 2718 | SEPARATION-TECHNIC | SETTLING CHARACTERISTICS C SWINE MANURE AS RELATEC TO DIGESTER LCADING KEYWORDS SEPA |
| 200 | 75 | 2719 | SEPARATION-TECHNIQ | A ROTATING CONICAL SCREEN SEPARATOR FOR LIQUID-SOLIC SEPARATION OF BEEF WASTE KEYWORDS |
| 200 | 75 | 2720 | SEPARATICN-TECHNIC | EVALUATION CF SCLIDS SEPARATICN DEVICES KEYWORCS SEPARATION-TECHNIQUES SCREENS SETTLIN |
| 200 | 64 | 17C1 | SEPTIC-TANKS | LIQUID HANDLING PRCCESSES FCR POULTRY MANURE UTILIZATICN KEYWORDS LIQUID-WASTES WASTE- |
| 300 | 74 | 1860 | SEPTIC-TANKS | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPCINT SOURCES KEYWCRDS NUTRIENTS EUTROPH |
| 100 | 72 | 2186 | SEPTIC-TANKS | HANDLING MILKING PARLOR WASTE KEYWORDS DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM |
| 100 | 72 | 2187 | SEPTIC-TANKS | NITRATES IN SOIL AND GRCUND WATER BENEATH IRRIGATED AND FERTILIZED CROPS KEYWORDS NIT |
| 30C | 75 | 2339 | SEPTIC-TANKS | GROUND WATER PCLLUTICN PROBLEMS IN THE NORTHWESTERN UN'TED STATES KEYWCRDS GROUNDWAT |
| 20C | 70 | 2392 | SEPTIC-TANKS | A PERSPECTIVE FOR CONNECTICUT KEYWORDS CONNECTICUT POULTRY DAIRY-INDUSTRY AGRICULTURA |
| 200 | 75 | 2661 | SERPENTINE-WATERWA | CIRECT LAND DISPOSAL OF FEEDLCT RUNCFF KEYWORCS AGRICULTURAL-RUNOFF NUTRIENTS LAND-DI |
| 600 | 72 | 1993 | SETTLEABLE-SOLIDS | STATIONARY SLOPING SCREEN TO SEPARATE SCLIDS FRCM DAIRY CATTLE MANURE SLURRIES KEYWORD |
| 400 | 74 | 2232 | SETTLEABLE-SOLICS | EPA ANC THE FISH FARMER KEYWCRDS FISH-FARMING REGULATIONS EFFLUENT PONDS SUSPENDED-S |
| 100 | 69 | 2380 | SETTLEC-SOLIDS | BICLOGICAL TREATMENT OF PCULTRY MANURE COLLECTEC FROM CAGEC LAYING HENS KEYWORDS WAST |
| 600 | 71 | 1718 | SETTLING | SYSTEM CCMPONENTS TO SEPARATE SCLIDS ANC LIQUIDS KEYWCRDS SOLID-WASTES LIQUID-WASTES |
| 600 | 74 | 1748 | SETTLING | FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SCLIDS KEYWORDS FLCCCULATION CATTLE FL |
| 600 | 73 | 1754 | SETTLING | BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING KEYWORDS FEEDLOTS AGRICULTUR |
| 100 | 69 | 2380 | SETTLING | BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTEC FROM CAGEC LAYING HENS KEYWORDS WAST |
| 200 | 73 | 2482 | SETTLING | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWCRDS HYCRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 200 | 75 | 2744 | SETTLING | PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM KEYWCRUS WASTE-TREATME |
| 200 | 73 | 1648 | SETTLING-BASINS | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS CDCR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 400 | 74 | 1770 | SETTLING-BASINS | COSTS NOTED FOR SOLID AND LIQUID WASTE SYSTEM KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LI |
| 100 | 74 | 1855 | SETTLING-BASINS | A RCTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER KEYWORDS SOLID-WAST |
| 100 | 72 | 2193 | SETTLING-BASINS | TAKING CARE OF WASTES FROM THE TROUT FARM KEYWORCS FISH-HATCHERIES TROUT WATER-POLLUT |
| 400 | 72 | 2320 | SETTLING-BASINS | THINK OF MANURE AS A RESOURCE-NCT A WASTE KEYWCRUS WATER-POLLUTION AGRICULTURAL-RUNOF |
| 200 | 73 | 2438 | SETTLING-BASINS | DESIGN AND CONSTRUCTION OF HOLDING PONDS ANC LAGCONS KEYWORDS WASTE-DISPOSAL LAGOONS |
| 300 | 71 | 2523 | SETTLING-BASINS | FEEDLOT WASTE DISPCSAL ANC WATER POLLUTION KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF WATE |
| 300 | 73 | 2039 | SETTLING-BASIN | DEMONSTRATION OF WASTE DISPCSAL SYSTEM KEYWCRDS CATTLE HOGS ANIMAL-WASTES SHEEP CHEMI |
| 20C | 73 | 2478 | SETTLING-BASIN | SOLIDS SEPARATICN KEYWCRUS SEPARATICN-TECHNIQUES SCLID-WASTES SLURRIES SETTLING-BASIN |
| 200 | 75 | 2610 | SETTLING-BASIN | AN ILLINOIS FEEDLOT RUNCFF CONTROL PROJECT KEYWORDS ILLINOIS FEEDLOTS DESIGN SPRINKLE |
| 200 | 75 | 2704 | SETTLING-CHAMBER | FIELD EVALUATION OF A SETTLING CHAMBER FOR SWINE WASTES KEYWORDS SEPARATION-TECHNIQUES |
| 300 | 71 | 2196 | SETTLING-CHANNELS | FEECLOT WASTE MANAGEMENT-WHY AND HOW KEYWORDS FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON |
| 300 | 71 | 2523 | SETTLING-CHANNELS | FEEDLCT WASTE DISPCSAL ANC WATER PCLLUTION KEYWCRDS FEFDLOTS AGRICULTURAL-RUNCFF WATE |
| 200 | 75 | 2718 | SETTLING-CHARACTER | SETTLING CHARACTERISTICS CF SWINE MANURE AS RELATED TO DIGESTER LOACING KEYWORDS SEPA |
| 300 | 74 | 1891 | SETTLING-POND | A WASTE TREATMENT SYSTEM FOR CONFINEC HOG RAISING OPERATIONS KEYWCRDS SWINE WASTE-TRE |
| 200 | 73 | 2478 | SETTLING-PONC | SOLIDS SEPARATION KEYWCRDS SEPARATICN-TECHNIQUES SCLID-WASTES SLURRIES SETTLING-BASIN |
| 200 | 69 | 1760 | SETTLING-TANKS | HYDRAULIC HANDLING CF PCULTRY MANURE INTEGRATED INTC AN ALGAL RECOVERY SYSTEM KEYWORDS |
| 600 | 72 | 2262 | SETTLING-TANKS | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STCRAGE TR |
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| 100 | 65 | 2542 | SETTLING-TANK | DEVELOPMENTS IN HOG MANURE DISPCSAL KEYWORDS WASTE-DISPOSAL LAGOONS CLEANING DESIGN S |
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200 75 2630 STATE-OF-THE-ART   SWINE PRODUCTION AND WASTE MANAGEMENT-STATE OF THE ART KEYWORDS  SWINE ECONOMICS STATE-
200 75 2644 STATE-OF-THE-ART   NUTRIENT AVAILABILITY FROM OXIDATION DITCHES  KEYWORDS NUTRIENTS AEROBIC-TREATMENT FARM
700 69 1690 STATISTICAL-MODELS ZETA POTENTIAL OF COLLOIDAL SUSPENSIONS FROM A BEEF CATTLE FEEDLOT SURFACE  KEYWORDS  ZE
200 72 1908 STATUS-REPORT      A STATUS REPORT ON AGRICULTURAL AND MUNICIPAL WASTE TREATMENT LAGOONS IN MISSISSIPPI  K
400 73 1859 STEAM              PROCESS CONVERTS ANIMAL WASTES TO OIL  KEYWORDS  FARM-WASTES OIL FEEDLOTS ENERGY WASTE-
100 71 2424 STEAM-DISTILLATION VOLATILIZATION OF NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS  KEYWORDS  FEEDL
300 74 1629 STOCKING           CONTROL OF DUST FROM CATTLE FEEDLOTS  KEYWORDS  CONTROL DUSTS CATTLE FEEDLOTS SPRINKLIN
300 73 2096 STOCKING-DENSITY   SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING  KEYWORDS  WASTE-DISPOSAL SLABS COSTS ODORS LA
600 71 1719 STOCKPILING        SWINE MANURE COLLECTION AND REMOVAL SYSTEMS  KEYWORDS SWINE COLLECTION REMOVAL CONFINEM
400 73 1662 STOCKYARDS         THESE STOCKYARDS SOLUTIONS COULD WORK FOR YOU  KEYWORDS LIVESTOCK FEEDLOTS MANAGEMENT L
300 73 2039 STOCKYARDS         DEMONSTRATION OF WASTE DISPOSAL SYSTEM  KEYWORDS  CATTLE HOGS ANIMAL-WASTES SHEEP CHEMI
600 73 1892 STORAGE-BASINS     IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI  KEY
200 71 1929 STORAGE-CAPACITY   MANAGEMENT OF RUNOFF WATER IN RELATION TO FEEDLOT OPERATIONS  KEYWORDS  FEEDLOTS AGRICU
200 64 1698 STORAGE-PITS       HYDRAULIC COLLECTION OF POULTRY WASTE  KEYWORDS  POULTRY HYDRAULIC-COLLECTION ODOR DESI
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|---|---|---|---|---|
| 600 | 66 | 1743 | STORAGE-PITS | STRUCTURAL ANALYSIS OF FLOOR GRIDS FOR CONFINMENET CATTLE FEEDING SYSTEMS KEYWORDS CO |
| 300 | 74 | 1794 | STORAGE-PITS | LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS KEYWORDS LIQUID-WASTES MANAGEMENT SWINE |
| 300 | 72 | 1830 | STORAGE-PITS | LIQUID MANURE MANAGEMENT FOR SWINE KEYWORDS LIQUID-WASTES SWINE WASTE-MANAGEMENT MANU |
| 200 | 75 | 2632 | STORAGE-PITS | MANAGING A SUCCESSFUL LIQUID SWINE MANURE MANAGEMENT SYSTEM KEYWORDS LIQUID-WASTES WA |
| 200 | 75 | 2693 | STORAGE-PITS | EXHAUST SYSTEMS FOR UNDERFLOOR LIQUID MANURE PITS KEYWORDS ODOR AIR-POLLUTION DESIGN |
| 400 | 74 | 2418 | STORAGE-POND | CHINO VALLEY SHAKER KEYWORDS DAIRY-INDUSTRY CALIFORNIA FERTILIZERS ODOR SPRINKLER-IRR |
| 100 | 74 | 2327 | STORAGE-REQUIREMEN | PERSISTENCE OF SALMONELLAE IN POULTRY EXCRETA KEYWORDS POULTRY SALMONELLA WASTE-STORAG |
| 400 | 74 | 2417 | STORAGE-REQUIREMEN | SOLID WASTE HANDLING KEYWORDS SOLID-WASTES SLURRIES DAIRY-INDUSTRY WASTE-STORAGE STOR |
| 600 | 71 | 1730 | STORAGE-TANKS | SOIL CONSERVATION SERVICE PROGRAM IN ANIMAL WASTE MANAGEMENT KEYWORDS SOIL-CONSERVATI |
| 300 | 72 | 1802 | STORAGE-TANKS | ENVIRONMENTAL ECONOMIC AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE M |
| 100 | 74 | 1894 | STORAGE-TANKS | HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS KEYWORDS DES |
| 400 | 74 | 2417 | STORAGE-TANKS | SOLID WASTE HANDLING KEYWORDS SOLID-WASTES SLURRIES DAIRY-INDUSTRY WASTE-STORAGE STOR |
| 700 | 73 | 2583 | STORAGE-TANK | CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK |
| 400 | 72 | 2538 | STORAGE-TIME | FRESH WASTES HAVE MORE NUTRIENTS KEYWORDS POULTRY PERFORMANCE DIETS PROTEINS NUTRIENT |
| 700 | 72 | 1706 | STORM-RUNOFF | WATER QUALITY OF STORM RUNOFF FROM A TEXAS BEEF FEEDLOT KEYWORDS WATER-QUALITY STORM-R |
| 600 | 74 | 1756 | STORM-RUNOFF | ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN |
| 300 | 72 | 2533 | STORM-RUNOFF | DAIRY WASTE STORAGE PONDS FOR SOIL PLANT RECYCLING KEYWORDS DAIRY-INDUSTRY WASTE-STOR |
| 700 | 72 | 2315 | STRATIFICATION | THE STRATIFICATION OF AN ANAEROBIC DAIRY MANURE LAGOON KEYWORDS DAIRY-INDUSTRY STRATIF |
| 300 | 68 | 2220 | STRATISCAL-METHODS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 100 | 72 | 2170 | STRATUM | DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION KEYWORD |
| 600 | 74 | 2068 | STREAMS | EFFECT OF A LIVESTOCK WINTERING OPERATION ON A WESTERN MOUNTAIN STREAM KEYWORDS STREA |
| 400 | 73 | 2098 | STREAMS | TREAT YOUR WASTE RIGHT KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL SEWAGE LOUISIANA LAGOO |
| 300 | 68 | 2220 | STREPTOCOCCUS | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 200 | 75 | 2670 | STREPTOCOCCUS | DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY KEYWORDS LAGOONS DAIRY-INDUSTRY TENNESSEE |
| 200 | 75 | 2674 | STREPTOCOCCUS | EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED |
| 100 | 71 | 2767 | STREPTOCOCCUS | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 700 | 69 | 1863 | STREPTOCOCCUS-BOVI | METHODS FOR RAPID IDENTIFICATION AND ENUMERATION OF STREPTOCOCCUS BOVIS FROM WATER KEY |
| 300 | | 1774 | STRESS | EFFECT OF ATMOSPHERIC AMMONIA AND THE STRESS OF INFECTIOUS BRONCHITIS VACCINATION ON L |
| 100 | 73 | 2226 | STRESS | INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH LEPOMI |
| 400 | 73 | 2504 | STRIP-MINES | STRIP MINE FEEDLOTS KEYWORDS STRIP-MINES FEEDLOTS CATTLE PERFORMANCE RUNOFF OHIO WAS |
| 200 | 75 | 2716 | STRUCTURES | SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST DAIRY |
| 400 | 74 | 2094 | SUBDU | NEW ODOR CONTROL PRODUCT NOW AVAILABLE KEYWORDS ODOR CONTROL BACTERIA FEEDLOTS FARM-W |
| 100 | 72 | 1667 | SUBSTRATES | THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES KEYWORDS THERMOPHI |
| 100 | 74 | 2541 | SUBSTRATE | RECOVERING PROTEIN FROM DAIRY CATTLE WASTES KEYWORDS PROTEINS DAIRY-INDUSTRY SEPARATIO |
| 100 | 71 | 2570 | SUBSTRATE | BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN KEYWORDS MICROORGANISMS TOXICITY FEEDLOT |
| 700 | 71 | 1791 | SUBSURFACE-DISPOSA | PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM KE |
| 300 | 73 | 2516 | SUBSURFACE-DISPOSA | IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS KEYWORDS MICHIGAN DAIRY-INDUSTRY LEGAL |
| 100 | 71 | 2413 | SUBSURFACE-DISTRIB | SUBSURFACE DISTRIBUTION OF NITRATES BELOW COMMERCIAL CATTLE FEEDLOTS TEXAS HIGH PLAINS |
| 600 | 75 | 2492 | SUBSURFACE-INJECTI | ANIMAL WASTE MANAGEMENT THROUGH CONTINUOUS SUBSURFACE INJECTION KEYWORDS WASTE-DISPOS |
| 200 | 75 | 2755 | SUBSURFACE-INJECTI | ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION KEYW |
| 200 | 75 | 2715 | SUB-SOC-INJECTION | EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL KEYWORDS |
| 400 | 75 | 2071 | SULFA-DRUGS | DUNG HO-FDA SETS REGS ON RECYCLED FEED KEYWORDS REGULATION RECYCLING ANIMAL-WASTES FE |
| 100 | 69 | 1659 | SULFUR | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 400 | 74 | 1769 | SULFUR | CONVERTING ANIMAL WASTES TO OIL KEYWORDS OIL FUELS RECYCLING PYROLYSIS CELLULOSE ENER |
| 300 | 71 | 1882 | SULFUR | RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE ROLE OF LAND AND SOIL |
| 200 | 74 | 2185 | SULFUR | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 700 | 68 | 1826 | SULFUR-COMPOUNDS | ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING KEYWORDS SWINE CONFI |
| 300 | 71 | 2077 | SULFUR-DIOXIDE | AIR POLLUTION AND AGRICULTURE KEYWORDS AGRICULTURE AIR-POLLUTION ARIZONA POLLUTANTS S |
| 700 | 65 | 2188 | SULFUR-DIOXIDE | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 600 | 64 | 2204 | SULFUR-DIOXIDE | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 400 | 72 | 2289 | SULPHUR-DIOXIDE | MOLASSES FROM MANURE KEYWORDS FEEDS SLUDGE PROTEINS MANURE MOLASSES SULPHUR-DIOXIDE |
| 300 | 48 | 2414 | SUPERPHOSPHATE | POULTRY MANURE ITS PRESERVATION DEODORIZATION AND DISINFECTION KEYWORDS POULTRY FARM- |
| 400 | 72 | 2511 | SUPERPHOSPHATE | SHOULD SUPERPHOSPHATE BE USED ON MANURE KEYWORDS POULTRY DRYING FERTILIZERS ECONOMIC |
| 600 | 73 | 1803 | SUPPLEMENT | FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE C |
| 200 | 71 | 1928 | SURFACES | CROP RESPONSE TO WASTE MATERIALS FROM VARIOUS FEEDLOT COLLECTION SYSTEMS KEYWORDS CRO |
| 300 | 74 | 1891 | SURFACE-AERATORS | A WASTE TREATMENT SYSTEM FOR CONFINED HOG RAISING OPERATIONS KEYWORDS SWINE WASTE-TRE |
| 100 | 72 | 2580 | SURFACE-AERATOR | THE TREATMENT OF LIVESTOCK WASTES KEYWORDS LIVESTOCK WASTE-TREATMENT FEEDLOTS CONFINE |
| 300 | 74 | 2791 | SURFACE-AERATOR | THE TREATMENT OF PIGGERY WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL SWINE SCOTLA |
| 400 | 74 | 2066 | SURFACE-IRRIGATION | HOW IRRIGATION CAN BE USED TO HANDLE MANURE KEYWORDS IRRIGATION WASTE-DISPOSAL COSTS D |
| 700 | 71 | 1762 | SURFACE-LOADING | INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN W |
| 100 | 73 | 1639 | SURFACE-RUNOFF | EFFECTS OF SURFACE IRRIGATION WITH DAIRY MANURE SLURRIES ON THE QUALITY OF GROUNDWATER |
| 600 | 74 | 1684 | SURFACE-SLOPE | OUTDOOR BEEF CATTLE FEEDLOTS-PROPERTIES OF MANURE ACCUMULATIONS KEYWORDS CATTLE FEEDL |
| 200 | 71 | 1967 | SURFACE-WATERS | PHOSPHORUS IN OUR ENVIRONMENT KEYWORDS PHOSPHORUS FERTILIZERS SURFACE-WATERS ENVIRONM |
| 200 | 71 | 1972 | SURFACE-WATERS | PLANNING LAND APPLICATION OF MANURE KEYWORDS PLANNING AGRICULTURAL-RUNOFF SURFACE-WATE |
| 200 | 64 | 2182 | SURFACE-WATERS | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N |
| 100 | 73 | 1663 | SURVEYS | INFLUENCE OF AGRICULTURAL PRACTICES ON WATER QUALITY IN NEBRASKA A SURVEY OF STREAMS GR |
| 600 | | 2777 | SURVEYS | GROUND WATER CONTAMINATION BY DISSOLVED NITRATE KEYWORDS NITRATES FERTILIZERS GEOCHEMI |
| 100 | 73 | 1685 | SURVIVAL | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 100 | 75 | 2365 | SURVIVAL | SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT KEYWORDS LAGOONS EF |
| 300 | 73 | 2384 | SURVIVAL | SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS |
| 200 | 75 | 2587 | SURVIVAL | SURVIVAL OF SALMONELLAE TOTAL COLIFORMS AND FECAL COLIFORMS IN SWINE WASTE LAGOON EFFLU |
| 700 | 73 | 1652 | SUSPENDED-SOLIDS | DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM KEYWORDS WASTE-TREATMENT AGR |
| 100 | 73 | 1905 | SUSPENDED-SOLIDS | AEROBIC TREATMENT OF PIGGERY WASTE KEYWORDS AEROBIC-TREATMENT SWINE EFFLUENTS SUSPEND |
| 100 | 71 | 2092 | SUSPENDED-SOLIDS | FARM EFFLUENT-ELECTRICAL DISPOSAL METHODS KEYWORDS EFFLUENTS FARM-WASTES SUSPENDED-SOL |
| 400 | 74 | 2232 | SUSPENDED-SOLIDS | EPA AND THE FISH FARMER KEYWORDS FISH-FARMING REGULATIONS EFFLUENT PONDS SUSPENDED-S |
| 100 | 71 | 2241 | SUSPENDED-SOLIDS | THE PERFORMANCE OF AN EXPERIMENTAL HIGH RATE BIOLOGICAL FILTRATION TOWER WHEN TREATING |
| 700 | 67 | 2363 | SUSPENDED-SOLIDS | ACTIVATED SLUDGE STABILIZATION OF SWINE WASTE KEYWORDS MATHEMATICAL-MODELS ACTIVATED-S |
| 300 | 75 | 2411 | SUSPENDED-SOLIDS | SURFACE RUNOFF IN DAIRIES KEYWORDS AGRICULTURAL-RUNOFF DAIRY-INDUSTRY WATER-POLLUTION |
| 700 | 70 | 2781 | SUSPENDED-SOLIDS | AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS KEYWOR |
| 200 | 75 | 2692 | SWEDEN | MANURE GASES AND AIR CURRENTS IN LIVESTOCK HOUSING KEYWORDS LIVESTOCK VENTILATION HYDR |
| 100 | 73 | 1635 | SWINE | MINIMUM AERATION FOR CONTROL OF ODORS FROM SWINE WASTES KEYWORDS AERATION ODOR-CONTROL |
| 400 | 71 | 1641 | SWINE | TEST SWINE WASTE DISPOSAL SYSTEMS KEYWORDS SWINE WASTE-DISPOSAL TESTING WATER-POLLUTI |
| 700 | 69 | 1650 | SWINE | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN-D |
| 700 | 67 | 1651 | SWINE | MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE KEYWORDS |
| 100 | 72 | 1661 | SWINE | OXIDATION WHEEL ELIMINATES ODORS MANURE HANDLING AND POLLUTION KEYWORDS WASTE-HANDLIN |
| 300 | 71 | 1672 | SWINE | EFFECT OF APPLYING SWINE FECES ON SOIL AND PLANT MINERAL LEVELS KEYWORDS SWINE FECES |
| 400 | 73 | 1674 | SWINE | NOW NO ODOR WASTE HANDLING KEYWORDS ODOR WASTE-HANDLING SWINE CENTRIFUGAL-PUMPS SEWAG |
| 100 | 72 | 1675 | SWINE | NUTRITIVE VALUE OF AEROBICALLY SUSTAINED SWINE EXCREMENT KEYWORDS NUTRIENTS SWINE EXCR |
| 700 | 66 | 1707 | SWINE | AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS KEYWO |
| 700 | 69 | 1708 | SWINE | SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT KEYWORDS SOILS P |
| 600 | 71 | 1719 | SWINE | SWINE MANURE COLLECTION AND REMOVAL SYSTEMS KEYWORDS SWINE COLLECTION REMOVAL CONFINEM |
| 600 | 71 | 1723 | SWINE | SWINE SYSTEMS FOR IOWA AND NORTH CENTRAL STATES KEYWORDS SWINE WASTE-MANAGEMENT IOWA E |
| 600 | 71 | 1727 | SWINE | ECONOMIC CONSIDERATIONS INVOLVED IN SELECTING TYPES OF CONFINEMENT AND WASTE DISPOSAL S |
| 700 | 71 | 1732 | SWINE | PHOTOGRAPHIC STUDIES OF THE DUNGING BEHAVIOR OF PIGS IN CONFINEMENT KEYWORDS SWINE CO |
| 700 | 64 | 1735 | SWINE | ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING KEYWORDS ODOR SWINE CONFINEMENT-HOUSING |
| 700 | 70 | 1736 | SWINE | ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION KEYWORDS ODOR CONT |
| 600 | 71 | 1737 | SWINE | SLOTTED FLOORS FOR HOGS-PROGRESS AND TRENDS KEYWORDS SWINE DESIGN CONSTRUCTION SLOTTE |
| 700 | 71 | 1766 | SWINE | WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE KEY |
| 200 | 73 | 1789 | SWINE | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
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700 68 1826   SWINE        ATMCSPHERIC COMPOSITION IN AN ENCLCSED SWINE PRCCUCTICN BUILDING  KEYWORDS  SWINE CONFI
300 72 1830   SWINE        LIQUID MANURE MANAGEMENT FOR SWINE  KEYWORDS  LIQUIC-WASTES SWINE WASTE-MANAGEMENT MANU
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100 72 1913   SWINE        EFFECT OF SLOTTED FLOORS ON AIR FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILD
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400 72 2376   SWINE        HOW TO DISPOSE OF MANURE AND STAY OUT OF COURT  KEYWORDS WASTE-MANAGEMENT LEGAL-ASPECTS
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| 200 | 75 | 2659 | SWINE | SEPARATING NUTRIENTS TO ENHANCE SWINE WASTE DIGESTION KEYWORDS ANAEROBIC-DIGESTION MET |
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| 200 | 75 | 2683 | SWINE | OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR L AND EUGLENA SP KEYWORDS |
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| 200 | 75 | 2696 | SWINE | ODOR CONTROL OF LIQUID DAIRY AND SWINE MANURE USING CHEMICAL AND BIOLOGICAL TREATMENTS |
| 200 | 75 | 2700 | SWINE | IF YOU CANNOT SPREAD IT TREAT IT KEYWORDS SLURRIES WASTE-TREATMENT SEPARATION-TECHNIQ |
| 200 | 75 | 2704 | SWINE | FIELD EVALUATION OF A SETTLING CHAMBER FOR SWINE WASTES KEYWORDS SEPARATION-TECHNIQUES |
| 200 | 75 | 2707 | SWINE | A COMPUTER SIMULATION OF STORAGE AND LAND DISPOSAL OF SWINE WASTE KEYWORDS WASTE-STOR |
| 200 | 75 | 2716 | SWINE | SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST DAIRY |
| 200 | 75 | 2717 | SWINE | APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT KEYWORDS |
| 200 | 75 | 2718 | SWINE | SETTLING CHARACTERISTICS OF SWINE MANURE AS RELATED TO DIGESTER LOADING KEYWORDS SEPA |
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| 200 | 75 | 2734 | SWINE | A THEORETICAL DESCRIPTION OF AEROBIC TREATMENT KEYWORDS AEROBIC-TREATMENT POULTRY MODE |
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| 200 | 75 | 2753 | SWINE | PLANT AND SOIL EFFECTS OF SWINE LAGOON EFFLUENT APPLIED TO COASTAL BERMUDAGRASS KEYWO |
| 700 | 74 | 2766 | SWINE | AQUATIC ECOLOGY OF SWINE WASTE LAGOONS BEFORE AND AFTER ARTIFICIAL AERATION KEYWORDS |
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| 100 | 74 | 2775 | SWINE | EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO |
| 600 | 71 | 2778 | SWINE | A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF DAIRY SHEEP AND SWINE FEEDLOT |
| 100 | 71 | 2782 | SWINE | LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS KEYWORDS COMPUTER-MODELS WASTE- |
| 100 | 74 | 2784 | SWINE | REGIONAL MANAGEMENT OF ANIMAL MANURES-A MODEL FOR COLLECTION STORAGE LOCATION AND DISTR |
| 300 | 74 | 2791 | SWINE | THE TREATMENT OF PIGGERY WASTES KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL SWINE SCOTLA |
| 400 | 72 | 2795 | SWINE | FINALLY A CREATIVE PROFITABLE SOLUTION TO AGE OLD WASTE PROBLEM KEYWORDS CATTLE MUNIC |
| 100 | 72 | 2796 | SWINE | THE DISPOSAL OF COPPER ENRICHED PIG MANURE SLURRY ON GRASSLAND KEYWORDS COPPER SLURRI |
| 400 | 75 | 2814 | SWINE | CONVERSION OF SWINE MANURE TO PROTEIN KEYWORDS RECYCLING ALGAE PROTEINS FEEDS SWINE |
| 700 | 65 | 2188 | SWINE-BUILDINGS | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 700 | 71 | 2780 | SWINE-BUILDINGS | AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS KEYWORDS ODOR CONFINEMENT-PENS F |
| 300 | 74 | 2248 | SWINE-BUILDING | IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUR |
| 200 | 73 | 2101 | SWINE-FINISHING-HO | EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS KEYWORDS GASES DUST AIR-POLLUTION AMMO |
| 200 | 69 | 2488 | SWINE-INDUSTRY | PERSONAL SIDELIGHTS AND OBSERVATIONS OF THE HBI TRIAL KEYWORDS ODOR LAGOONS ZONING LAW |
| 200 | 75 | 2635 | SWINE-PRODUCTION | DOUBLE E FARMS-SWINE INSTALLATION KEYWORDS DESIGN LAGOONS COSTS EQUIPMENT MAINTENANCE |
| 200 | 74 | 2185 | SYNTHESIS | PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANUR |
| 300 | 74 | 1960 | SYNTHESIS-GAS | CONVERSION OF CATTLE FEEDLOT WASTES TO AMMONIA SYNTHESIS GAS KEYWORDS CATTLE FEEDLOTS |
| 700 | 69 | 1656 | SYSTEMS-ANALYSIS | MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF KEYWORDS MATHEMATI |
| 200 | 74 | 2003 | SYSTEMS-ANALYSIS | AN ENVIRONMENTAL ANALYSIS OF FEEDLOT SYSTEMS KEYWORDS FEEDLOTS SYSTEMS-ANALYSIS ENVIRO |
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| 400 | 71 | 2296 | TANKER-SPREADER | FOREST LAND FOR MANURE DISPOSAL KEYWORDS WASTE-DISPOSAL FOREST-MANAGEMENT NITROGEN LI |
| 400 | 73 | 2552 | TANKER-SYSTEMS | MOST PIG WASTE DISPOSAL SYSTEMS SATISFACTORY KEYWORDS LAGOONS DESIGN WASTE-DISPOSAL PU |
| 200 | 75 | 2613 | TANKS. | UTILIZATION OF BEEF CATTLE WASTE FROM A SLOTTED FLOOR DEEP PIT BARN KEYWORDS CONFINEM |
| 300 | 74 | 1794 | TANK-WAGONS | LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS KEYWORDS LIQUID-WASTES MANAGEMENT SWINE |
| 200 | 73 | 2180 | TAR | HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS KEYWORDS GASES RECYCLING CATTLE AU |
| 400 | 74 | 1861 | TASTE | INCLUSION OF DRIED POULTRY WASTE AS A FEED INGREDIENT IN CATFISH RATIONS KEYWORDS CAT |
| 400 | 72 | 1938 | TASTE | SAGEBRUSH FOR ODOR CONTROL-IN THE FEED OR THE MANURE KEYWORDS SAGEBRUSH FEEDS PERFORMA |
| 400 | 75 | 2349 | TASTE | RECYCLING POULTRY LITTER AS SILAGE KEYWORDS RECYCLING SILAGE CATTLE WEIGHT TASTE POUL |
| 400 | 75 | 2350 | TASTE | CATFISH ON DPW KEYWORDS CATFISHES DIETS PERFORMANCE TASTE COSTS DRIED-POULTRY-WASTE |
| 400 | 75 | 2512 | TASTE | INFLUENCE OF FEEDING DEHYDRATED POULTRY WASTE ON BROILER GROWTH AND MEAT FLAVOR AND COM |
| 700 | 71 | 2771 | TECHNICAL-ASPECTS | ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATI |
| 400 | 72 | 2167 | TECHNICAL-ASSISTAN | PLANNING FEEDLOT WASTE DISPOSAL KEYWORDS PLANNING FEEDLOTS WASTE-DISPOSAL WASTE-STORA |
| 300 | 71 | 2196 | TECHNICAL-ASSISTAN | FEEDLOT WASTE MANAGEMENT-WHY AND HOW KEYWORDS FEEDLOTS LEGAL-ASPECTS TERRACING LAGOON |
| 300 | 74 | 2257 | TECHNICAL-ASSISTAN | CURRENT LIVESTOCK POLLUTION REGULATIONS KEYWORDS WATER-POLLUTION PERMITS LIVESTOCK PO |
| 600 | 72 | 1993 | TECHNIQUES | STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES KEYWORD |
| 600 | 71 | 1714 | TECHNOLOGY | ANIMAL WASTE MANAGEMENT-COMMENTS ON THE NATIONAL SITUATION KEYWORDS WASTE-MANAGEMENT |
| 500 | 74 | 2503 | TECHNOLOGY | THE RECYCLING OF ORGANIC WASTE-INTENSIVE CATTLE PRODUCTION KEYWORDS RECYCLING ORGANIC |
| 600 | 75 | 2546 | TECHNOLOGY | NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT KEYWORDS TECHNOLOGY NUTRIENTS NITROG |
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| 700 | 69 | 1650 | TEMPERATURE | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN-D |
| 700 | 71 | 1766 | TEMPERATURE | WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE KEY |
| 200 | 74 | 1777 | TEMPERATURE | MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES KEY |
| 100 | 73 | 1801 | TEMPERATURE | ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE K |
| 100 | 73 | 1828 | TEMPERATURE | THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMID |
| 100 | 73 | 1832 | TEMPERATURE | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 100 | 72 | 1960 | TEMPERATURE | COMPARISON OF SELECTED ENVIRONMENTAL CONDITIONS AND BEEF CATTLE PERFORMANCE IN POLE TYP |
| 100 | 74 | 2069 | TEMPERATURE | WINTER OPERATION OF A MODIFIED OPEN FRONT FINISHING HOUSE FOR SWINE KEYWORDS WINTER D |
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| 100 | 74 | 2189 | TEMPERATURE | DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA KEYWORDS DIGESTION FARM-WASTES POULTRY |
| 100 | 72 | 2197 | TEMPERATURE | CHANGING FROM DUMPING TO RECYCLING PART III-COMPOSTING AND MISCELLANEOUS PROCESSES KEY |
| 100 | 71 | 2200 | TEMPERATURE | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 | 69 | 2216 | TEMPERATURE | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN- |
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| 700 | 71 | 2308 | TEMPERATURE | NITROSATION IN FEEDLOT MANURE KEYWORDS WASTE-STORAGE FEEDLOTS NITRITES AMINES TEMPERA |
| 100 | 74 | 2327 | TEMPERATURE | PERSISTENCE OF SALMONELLAE IN POULTRY EXCRETA KEYWORDS POULTRY SALMONELLA WASTE-STORAG |
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| 300 | 73 | 2384 | TEMPERATURE | SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL KEYWORDS PATHOGENIC-BACTERIA WASTE-DIS |
| 700 | 72 | 2401 | TEMPERATURE | DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA KEYWORDS POULTRY EQUAT |
| 400 | 73 | 2416 | TEMPERATURE | POULTRY MANURE COMPOSTING KEYWORDS AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST |
| 100 | 73 | 2431 | TEMPERATURE | NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE COLL |
| 200 | 73 | 2441 | TEMPERATURE | SELECTION OF PUMPS PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL |
| 700 | 72 | 2448 | TEMPERATURE | TRANSFORMATION MOVEMENT AND DISPOSAL OF NITROGEN FROM ANIMAL MANURE WASTES APPLIED TO S |
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200 73 1789  TEXAS                SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES  KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM
300    1792  TEXAS                SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF
100 73 1806  TEXAS                FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL  KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN
400 73 1812  TEXAS                FEEDING VARIATIONS CAN AFFECT WASTE  KEYWORDS  FEEDS FEED-LOTS CONFINEMENT-PENS TEXAS C
400 75 2322  TEXAS                NEW MANURE CONVERSION PLANT OPENED  KEYWORDS  RECYCLING FERTILIZERS FEEDS AEROBIC-DIGES
300 75 2335  TEXAS                ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES  KEYWORDS LEGAL-ASPECTS REGULATION DAIR
300 72 2386  TEXAS                ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE
100 71 2413  TEXAS                SUBSURFACE DISTRIBUTION OF NITRATES BELOW COMMERCIAL CATTLE FEEDLOTS TEXAS HIGH PLAINS
400 75 2501  TEXAS                MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS  KEYWORDS  RECYCLING BY-PRODUCTS FEED
200 75 2671  TEXAS                SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS  KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF GROUN
200 75 2691  TEXAS                EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS  KEYWORDS  FEED
200 75 2710  TEXAS                DESIGN RUNOFF VOLUME FROM FEEDLOTS IN THE SOUTHWESTERN GREAT PLAINS  KEYWORDS  DESIGN A
100 72 2799  TEXAS-TECHNOLOGICA   RETORTING FEEDLOT WASTES  KEYWORDS  FEEDLOTS ORGANIC-WASTES CARBON FUELS WATER-POLLUTIO
700 71 1766  THERMAL-CONDUCTIVI   WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
100 74 1951  THERMAL-CONDUCTIVI   EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE  KEYWORDS  MOISTURE-CO
400 73 1768  THERMAL-DECOMPOSIT   IS TOTAL RECYCLING OF HEN MANURE POSSIBLE  KEYWORDS  POULTRY RECYCLING FERMENTATION DIG
100 74 1951  THERMAL-DIFFUSIVIT   EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE  KEYWORDS  MOISTURE-CO
200 75 2631  THERMAL-DISCHARGES   SWINE WASTE NUTRIENT RECOVERY SYSTEM BASED ON THE USE OF THERMAL DISCHARGES  KEYWORDS
700 71 1766  THERMAL-ENVIRONMEN   WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
700 71 1766  THERMAL-INSULATION   WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
200 72 2168  THERMOCHEMICAL-EVA   THERMOCHEMICAL EVALUATION OF ANIMAL WASTE CONVERSION PROCESSES  KEYWORDS  RECYCLING GAS
700 71 1766  THERMOCOUPLE         WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
700 71 1766  THERMOMETERS         WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN FRONT HOUSE  KEY
400 74 1636  THERMOPHILIC-BACTE   MANURE IS FOOD FOR PROTEIN  KEYWORDS  MANURE CATTLE PROTEINS NUTRIENTS FERMENTATION THE
100 72 1667  THERMOPHILIC-BACTE   THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES  KEYWORDS  THERMOPHI
400 72 1945  THERMOPHILIC-BACTE   THIS PLANT WILL CONVERT WASTE INTO PROTEIN  KEYWORDS  FEEDS PROTEINS THERMOPHILIC-BACTE
400 72 2046  THERMOPHILIC-BACTE   BREAKTHROUGH IN THE FIGHT AGAINST POLLUTION  KEYWORDS THERMOPHILIC-BACTERIA WASTE-TREAT
400 72 2240  THERMOPHILIC-BACTE   GENERAL ELECTRIC TO RECYCLE BEEF MANURE INTO PROTEIN FEED AT NEW ARIZONA PLANT  KEYWORD
400 73 2416  THERMOPHILIC-BACTE   POULTRY MANURE COMPOSTING  KEYWORDS  AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST
300 74 2044  THERMOPHILIC-REACT   LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS  KEYWORDS  LIQ
600 74 2050  THERMOPHILIC-REACT   METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR  KEYWORDS  METHANE FEASIBILITY-S
700 72 2770  THIN-LAYER-DRYING-   DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA  KEYWORDS  POULTRY DRYIN
100 74 2045  THRESHOLD-LEVEL      CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN  STORED DAIRY MANURE  KEYWOR
200 75 2619  TIE-STALL-DAIRY-BA   A LIQUID MANURE MANAGEMENT SYSTEM IN A TIE STALL DAIRY BARN  KEYWORDS  LIQUID-WASTES DA
400 72 2230  TILTH                MANURE DECREASES NEED FOR FERTILIZER  KEYWORDS  FERTILIZERS NUTRIENTS MANURE TILTH CROP
700 71 1732  TIME-LAPSE-PHOTOGR   PHOTOGRAPHIC STUDIES OF THE DUNGING BEHAVIOR OF PIGS IN CONFINEMENT  KEYWORDS  SWINE CO
200 73 2436  TIPPING-BUCKET       MANURE HANDLING BY HYDRAULIC FLUSHING  KEYWORDS  DESIGN LIQUID-WASTES RECYCLING CONFINE
300 74 1678  TOPOGRAPHY           LOCATING A NEW FEEDLOT  KEYWORDS  FEEDLOTS SITE-SELECTION WATER-POLLUTION LIVESTOCK REG
200 72 1880  TOPOGRAPHY           EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS  KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES
300 72 2086  TOPOGRAPHY           HYDROLOGY AND CHARACTERISTICS OF FEEDLOT RUNOFF  KEYWORDS HYDROLOGY FEEDLOTS AGRICULTUR
200 69 2221  TOPOGRAPHY           WASTE CONTROL ALTERNATIVES  KEYWORDS  AGRICULTURAL-RUNOFF FEEDLOTS LAGOONS TOPOGRAPHY C
200 74 2033  TOTAL-DISSOLVED-SO   MANURE HOLDING POND SEALING STUDY  KEYWORDS  SEEPAGE NITRATES TOTAL-DISSOLVED-SOLIDS CO
300 74 2044  TOTAL-DISSOLVED-SO   LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS  KEYWORDS  LIQ
600 74 1749  TOTAL-SOLIDS         A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH  PONDS  KEYWORDS  EFFLUENT F
600 72 1993  TOTAL-SOLIDS         STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES  KEYWORD
200 73 2482  TOTAL-SOLIDS         HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE  KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES
200 75 2720  TOTAL-SOLIDS         EVALUATION OF SOLIDS SEPARATION DEVICES  KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN
200 75 2720  TOTAL-SUSPENDED-SO   EVALUATION OF SOLIDS SEPARATION DEVICES  KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN
200 75 2720  TOTAL-VOLATILE-SOL   EVALUATION OF SOLIDS SEPARATION DEVICES  KEYWORDS SEPARATION-TECHNIQUES SCREENS SETTLIN
100 61 1669  TOXICITY             TOXICITY TO FLY LARVAE OF THE FECES OF INSECTICIDE FED CATTLE  KEYWORDS  TOXICITY CATTL
100 61 1670  TOXICITY             TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE FED CATTLE  KEYWORD
100 65 1750  TOXICITY             COMPARATIVE EFFECTIVENESS AND PERSISTENCE OF CERTAIN INSECTICIDES IN POULTRY DROPPINGS
600 72 1875  TOXICITY             AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH ICTALURUS PUNCTATUS
100 72 2110  TOXICITY             TOXICITY OF SEAWATER TO COLIFORM BACTERIA  KEYWORDS  TOXICITY SEAWATER COLIFORMS BACTER
100 73 2121  TOXICITY             EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTE
200 64 2182  TOXICITY             NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS  NITRATES NITRITES N
700 65 2188  TOXICITY             AIR POLLUTANTS IN SWINE BUILDINGS  KEYWORDS  AIR-POLLUTION  SWINE CONFINEMENT-PENS FARM
400 71 2269  TOXICITY             MANURE ON MILLET  KEYWORDS  AMMONIA TOXICITY NITRATES MANURE MILLET APPLICATION-RATES
100 75 2272  TOXICITY             MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE  KEYWORDS  POULTR
100 73 2354  TOXICITY             HORN FLIES STABLE FLIES AND HOUSE FLIES-DEVELOPMENT IN FECES OF BOVINES TREATED ORALLY
200 73 2479  TOXICITY             ANAEROBIC DIGESTION OF LIVESTOCK WASTES AND THE PROSPECTS FOR METHANE PRODUCTION  KEYWO
100 70 2520  TOXICITY             POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANU
100 71 2570  TOXICITY             BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN  KEYWORDS MICROORGANISMS TOXICITY FEEDLOT
100 75 2790  TOXICITY             TOXICITY OF NITRITE TO CHANNEL CATFISH  KEYWORDS  CATFISHES NITRITES AMMONIA TOXICITY
700 73 2792  TOXICITY             THE EFFECT OF INCORPORATED ANIMAL MANURE AND PH ON THE SOLUBILITY OF SOIL MANGANESE  KE
100 72 2796  TOXICITY             THE DISPOSAL OF COPPER ENRICHED PIG MANURE SLURRY ON GRASSLAND  KEYWORDS  COPPER SLURRI
100 73 1806  TOXIC-FERMENTATION   FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL  KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN
400 74 1917  TRAFFIC-PATTERNS     DO FLUMES REALLY WORK  KEYWORDS  FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES
100 69 1659  TRANSFORMATIONS      ULTIMATE DISPOSAL OF WASTES TO SOIL  KEYWORDS  WASTES ULTIMATE-DISPOSAL RECYCLING WASTE
200 74 1777  TRANSFORMATION       MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES  KEY
300 71 1882  TRANSFORMATION       RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE  ROLE OF LAND AND SOIL
300 74 1678  TRANSPORTATION       LOCATING A NEW FEEDLOT  KEYWORDS  FEEDLOTS SITE-SELECTION WATER-POLLUTION LIVESTOCK REG
300 72 2088  TRANSPORTATION       ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS  KEYWORDS  LIQUID-WAST
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# KEYWORD INDEX

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|---|---|---|---|---|
| 200 | 74 | 2146 | TRANSPORTATION | LICENSING CONCERNS FOR THE TRANSPORTATION OF ANIMAL WASTES KEYWORDS ANIMAL-WASTES TRA |
| 100 | 73 | 2176 | TRANSPORTATION | RECYCLING ENERGY AND AGRICULTURAL ECONOMICS KEYWORDS RECYCLING ECONOMICS AGRICULTURE E |
| 600 | 72 | 2262 | TRANSPORTATION | PROPERTIES RELATED TO MATERIALS HANDLING KEYWORDS PHYSICAL-PROPERTIES WASTE-STORAGE TR |
| 300 | 73 | 2498 | TRANSPORTATION | SYNTHESIS GAS FROM FEEDLOT MANURE-A CONCEPTUAL DESIGN STUDY KEYWORDS DESIGN EQUIPMENT |
| 100 | 72 | 2800 | TRANSPORTATION-FUE | FUTURE ENERGY SOURCES FOR TRANSPORTATION KEYWORDS ENERGY RECYCLING ANIMAL-WASTES HYD |
| 200 | 63 | 2159 | TRANSPORTING | PROGRESS REPORT ON MANURE HARVESTING KEYWORDS POULTRY LIQUID-WASTES WASTE-STORAGE WAS |
| 600 | 72 | 2074 | TREATMENT | RECOVERING PROTEIN FROM ANIMAL WASTE KEYWORDS PROTEINS ANIMAL-WASTES CATTLE FEEDS TRE |
| 200 | 75 | 2729 | TREATMENT-EFFICIEN | LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES KEYWORDS LIQUID-WASTES EQUIPMENT AER |
| 300 | | 2571 | TRESPASS | LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA KEYWORDS LEGAL-ASPECTS FEEDLOTS NE |
| 200 | 64 | 2566 | TRICKLING-FILTERS | NEWER ASPECTS IN TREATMENT OF PACKING HOUSE AND FEEDLOT WASTES KEYWORDS WASTE-TREATME |
| 100 | 73 | 1673 | TROUT | TROUT METABOLISM CHARACTERISTICS AND THE RATIONAL DESIGN OF NITRIFICATION FACILITIES FO |
| 100 | 72 | 2193 | TROUT | TAKING CARE OF WASTES FROM THE TROUT FARM KEYWORDS FISH-HATCHERIES TROUT WATER-POLLUT |
| 300 | 73 | 2039 | TRUCK-WASHRACK | DEMONSTRATION OF WASTE DISPOSAL SYSTEM KEYWORDS CATTLE HOGS ANIMAL-WASTES SHEEP CHEMI |
| 400 | 72 | 2554 | TUBERCULOSIS | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 700 | 72 | 2409 | TURBIDITY | CHEMICAL COAGULATION OF FEEDLOT RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF CHEMICA |
| 200 | 75 | 2736 | TURBINE-AIR-AERATI | TURBINE AIR AERATION SYSTEM FOR POULTRY WASTES KEYWORDS POULTRY COSTS TURBINE-AIR-AERA |
| 200 | 74 | 2007 | TURKEYS | THE PRODUCTION RATE AND COMPOSITION OF MANURE FROM GROWING TURKEYS KEYWORDS NUTRIENT |
| 300 | 72 | 2386 | TURKEYS | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
| 200 | 75 | 2730 | TURN-OVER | INVESTIGATIONS ON THE PROCEDURE AND THE TURN-OVER OF ORGANIC MATTER BY HOT FERMENTATION |
| 600 | 72 | 1995 | TWO-CROP-FISH-PROD | A TWO CROP FISH PRODUCTION SYSTEM KEYWORDS FISH-FARMING FISH-MANAGEMENT FISH-HARVEST |
| 100 | 69 | 1659 | ULTIMATE-DISPOSAL | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 200 | 74 | 2008 | UNDERCAGE-DRYING-P | AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS KEYWORDS POULTRY |
| 300 | 74 | 2576 | UNDERGROUND-WASTE- | POLLUTED GROUNDWATER-A REVIEW OF THE SIGNIFICANT LITERATURE KEYWORDS GROUNDWATER-POLL |
| 300 | 74 | 2118 | UNINSULATED-HOUSIN | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 400 | 74 | 1797 | UNITED-BEEF-PRODUC | WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF KEYWORDS FARM-WASTES WASTE-DISPOSAL |
| 300 | 73 | 2407 | UNITED-KINGDOM | FARM WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL WASTE-TREATMENT AEROBIC-CONDITIONS EFFLUE |
| 100 | 73 | 2582 | UNITED-KINGDOM | THE LONG TERM MANAGEMENT OF ANIMAL MANURES KEYWORDS NUTRIENTS ODOR WATER-POLLUTION CRO |
| 200 | 75 | 2607 | UNITED-KINGDOM | IN-HOUSE MANURE DRYING-THE SLAT SYSTEM KEYWORDS DESIGN POULTRY DRYING ODOR VENTILATIO |
| 200 | 75 | 2618 | UNITED-KINGDOM | ADAPTATION OF A BRITISH WASTE MANAGEMENT SYSTEM TO THE US ENVIRONMENT KEYWORDS WASTE- |
| 100 | 72 | 2359 | UNITED-STATES | ANIMAL WASTE IN THE USA KEYWORDS ANIMAL-WASTES UNITED-STATES AEROBIC-TREATMENT POULTR |
| 400 | 72 | 2376 | UNITED-STATES | HOW TO DISPOSE OF MANURE AND STAY OUT OF COURT KEYWORDS WASTE-MANAGEMENT LEGAL-ASPECTS |
| 600 | 74 | 1949 | UNIVERSAL-SOIL-LOS | ERODIBILITY FACTOR OF BEEF CATTLE MANURE KEYWORDS CATTLE FEEDLOTS SOLID-WASTES WASTE |
| 300 | 74 | 2556 | UNIVERSAL-SOIL-LOS | WATER QUALITY AND SOIL EROSION FROM SURFACE APPLICATION OF TREATED LIQUID SWINE WASTE |
| 200 | 73 | 2475 | UNPAVED-FEEDLOTS | OUTDOOR UNPAVED FEEDLOT MANAGEMENT KEYWORDS FEEDLOTS DESIGN AGRICULTURAL-RUNOFF DRAIN |
| 200 | 75 | 2680 | UNPAVED-FEEDLOTS | A MYCOLOGICAL INVESTIGATION OF BEEF FEEDLOT MANURE IN A SEMIARID TEMPERATE CLIMATE KEY |
| 600 | 71 | 2531 | UNPAVED-LOTS | GUIDELINES FOR CATTLE FEEDLOT DESIGN KEYWORDS FEEDLOTS DESIGN-CRITERIA MONTANA ENGINE |
| 200 | 64 | 1704 | URBANIZATION | SOCIAL LEGAL AND ECONOMIC CONSIDERATIONS OF ANIMAL PRODUCTION IN URBANIZED AREAS KEYWO |
| 300 | 73 | 1785 | URBAN-AREAS | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 400 | 65 | 2037 | URBAN-DEVELOPMENT | MANURE ODORS CAN LAND YOU IN COURT KEYWORDS ODOR LEGAL-ASPECTS URBAN-DEVELOPMENT ZONI |
| 300 | 74 | 1860 | URBAN-RUNOFF | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 100 | 73 | 1832 | UREAS | DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE KEYW |
| 300 | 74 | 2217 | UREAS | COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING |
| 100 | 72 | 1657 | UREA | MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT SLURRY KEYWORDS NITROGEN FERTIL |
| 100 | 75 | 2272 | URIC-ACID | MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE KEYWORDS POULTR |
| 100 | 60 | 2518 | URIC-ACID | DISTRIBUTION OF THE MAJOR NITROGENOUS COMPOUNDS AND AMINO ACIDS IN CHICKEN URINE KEYWO |
| 400 | 74 | 2095 | URINE | URINARY EXCRETION OF QUINALDINE BY CHANNEL CATFISH KEYWORDS URINE CHANNEL-CATFISH QUI |
| 100 | 60 | 2518 | URINE | DISTRIBUTION OF THE MAJOR NITROGENOUS COMPOUNDS AND AMINO ACIDS IN CHICKEN URINE KEYWO |
| 400 | 72 | 2283 | UTAH | COSTS OF CONTROLLING FEEDLOT SURFACE RUNOFF KEYWORDS FEEDLOTS AGRICULTURAL-RUNOFF COST |
| 300 | 73 | 1835 | UTILITIES | STRUCTURES AND ENVIRONMENT HANDBOOK KEYWORDS PLANNING ENVIRONMENT WASTE-DISPOSAL DESI |
| 400 | 73 | 2067 | UTILIZATION | DRIED POULTRY MANURE UTILIZATION KEYWORDS RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO |
| 200 | 73 | 2482 | UTILIZATION | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 600 | 73 | 1852 | VACUUM-FILTRATION | VACUUM FILTRATION OF CATTLE MANURE KEYWORDS VACUUM-FILTRATION SLURRIES SLUDGE MOISTUR |
| 700 | 72 | 2316 | VACUUM-FILTRATION | LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION KEYWORDS SEPARATION-TEC |
| 200 | 73 | 2478 | VACUUM-FILTRATION | SOLIDS SEPARATION KEYWORDS SEPARATION-TECHNIQUES SOLID-WASTES SLURRIES SETTLING-BASIN |
| 200 | 75 | 2686 | VALUE | PARTICLE SIZE DISTRIBUTION OF LIVESTOCK WASTES KEYWORDS SEPARATION-TECHNIQUES FEEDS VA |
| 200 | 75 | 2691 | VAPOR-DILUTION | EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS KEYWORDS FEED |
| 200 | 75 | 2743 | VARIABILITY | BIOLOGICALLY-CONTROLLED LOADING OF AEROBIC STABILIZATION PLANTS KEYWORDS DESIGN-CRITE |
| 300 | 68 | 2220 | VARIATION-COEFFICI | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 200 | 73 | 2439 | VECTORS | MOSQUITO CONTROL IN LIVESTOCK WASTE LAGOONS IN ILLINOIS 1972 KEYWORDS LAGOONS MOSQUIT |
| 100 | 75 | 2456 | VECTORS | WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE KEY |
| 400 | 72 | 2554 | VECTORS | ENVIRONMENTAL HEALTH AND ANIMAL WASTES KEYWORDS ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z |
| 200 | 73 | 2439 | VEGETATION-REMOVAL | MOSQUITO CONTROL IN LIVESTOCK WASTE LAGOONS IN ILLINOIS 1972 KEYWORDS LAGOONS MOSQUIT |
| 700 | 65 | 1666 | VELOCITY | PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH KEYWORDS OXIDATION-DITCH PERFORMANCE |
| 200 | 73 | 2483 | VELOCITY | DESIGNING GUTTER FLUSHING SYSTEMS KEYWORDS DESIGN-CRITERIA HYDRAULIC-TRANSPORTATION M |
| 700 | 69 | 1650 | VENTILATION | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN-D |
| 700 | 64 | 1735 | VENTILATION | ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING KEYWORDS ODOR SWINE CONFINEMENT-HOUSING |
| 600 | 73 | 1763 | VENTILATION | DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR KEYWORDS DRYING FA |
| 400 | 74 | 1765 | VENTILATION | MANURE GASES KILL 25 HEAD IN OHIO KEYWORDS MANURE GASES CATTLE OHIO MORTALITY SLATTED |
| 600 | 73 | 1815 | VENTILATION | ELECTRICALLY MANAGING WASTE FROM CAGED LAYERS KEYWORDS WASTE-MANAGEMENT POULTRY VENTIL |
| 400 | 73 | 1854 | VENTILATION | TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES KEYWORDS AMMONIA LITTER BROILERS V |
| 100 | 72 | 1913 | VENTILATION | EFFECT OF SLOTTED FLOORS ON AIR FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILD |
| 100 | 72 | 1960 | VENTILATION | COMPARISON OF SELECTED ENVIRONMENTAL CONDITIONS AND BEEF CATTLE PERFORMANCE IN POLE TYP |
| 400 | 74 | 1994 | VENTILATION | THIS PARLOR MAKES USE OF NEW IDEAS KEYWORDS DAIRY-INDUSTRY DESIGN MONTANA ODOR VENTIL |
| 300 | 74 | 2118 | VENTILATION | FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD-SYSTEMS APPRO |
| 200 | 63 | 2157 | VENTILATION | INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL KEYWORDS LAGOONS POULTRY WASTE-DISPOSAL OD |
| 600 | 69 | 2175 | VENTILATION | THE DESIGN AND OPERATION OF AN OPEN FRONT SLOTTED FLOOR BEEF CONFINEMENT BUILDING KEYW |
| 700 | 65 | 2188 | VENTILATION | AIR POLLUTANTS IN SWINE BUILDINGS KEYWORDS AIR-POLLUTION SWINE CONFINEMENT-PENS FARM |
| 100 | 71 | 2200 | VENTILATION | THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPERSAL OF ATMOSPHERIC GASEOUS CONT |
| 600 | 64 | 2204 | VENTILATION | AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING KEYWORDS AIR-POLLUTION LI |
| 600 | 69 | 2216 | VENTILATION | CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL KEYWORDS CHEMICAL-OXYGEN- |
| 400 | 71 | 2271 | VENTILATION | POULTRY HOUSES THAT MAKE GOOD NEIGHBORS KEYWORDS ODOR DUSTS VENTILATION AMMONIA GASES |
| 400 | 71 | 2276 | VENTILATION | THE FALLACY OF DEEP PITS FOR POULTRY HOUSES KEYWORDS DESIGN VENTILATION NUTRIENTS COST |
| 100 | 71 | 2351 | VENTILATION | EXPERIMENTAL FACILITIES FOR STUDIES ON BEEF HOUSING AND EQUIPMENT KEYWORDS CONFINEMEN |
| 300 | 74 | 2428 | VENTILATION | UNDERFLOOR VENTILATION FOR SLOTTED FLOOR SWINE BUILDINGS KEYWORDS VENTILATION DESIGN C |
| 200 | 74 | 2458 | VENTILATION | THE MECHANICS OF AIR DRYING KEYWORDS POULTRY MOISTURE-CONTENT COSTS DEHYDRATION AEROB |
| 200 | 74 | 2466 | VENTILATION | HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE KEYWORDS CONFINEMENT-PENS DESIGN |
| 200 | 73 | 2477 | VENTILATION | EFFECTS OF WASTE MANAGEMENT SYSTEMS ON THE ANIMALS ENVIRONMENT KEYWORDS CONFINEMENT-P |
| 600 | 72 | 2489 | VENTILATION | PLANNING CONSIDERATIONS FOR CONFINEMENT SWINE FACILITIES KEYWORDS CONFINEMENT-PENS PL |
| 100 | 66 | 2513 | VENTILATION | THAT ODOR KEYWORDS ODOR CONTROL VENTILATION ABSORPTION ADSORPTION CHEMICAL-REACTION D |
| 100 | 73 | 2514 | VENTILATION | DAIRY WASTE MANAGEMENT SYSTEMS KEYWORDS DAIRY-INDUSTRY ODOR VENTILATION HOUSING STALL |
| 400 | 71 | 2572 | VENTILATION | THE DRY DEEP PIT SYSTEM KEYWORDS POULTRY ODOR WATER-POLLUTION VENTILATION DEEP-PITS F |
| 700 | 73 | 2583 | VENTILATION | CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK |
| 200 | 75 | 2607 | VENTILATION | IN-HOUSE MANURE DRYING-THE SLAT SYSTEM KEYWORDS DESIGN POULTRY DRYING ODOR VENTILATIO |
| 200 | 75 | 2620 | VENTILATION | A COMPLETE DAIRY LIQUID MANURE SYSTEM KEYWORDS DAIRY-INDUSTRY LIQUID-WASTES WASTE-STO |
| 200 | 75 | 2692 | VENTILATION | MANURE GASES AND AIR CURRENTS IN LIVESTOCK HOUSING KEYWORDS LIVESTOCK VENTILATION HYDR |
| 200 | 75 | 2693 | VENTILATION | EXHAUST SYSTEMS FOR UNDERFLOOR LIQUID MANURE PITS KEYWORDS ODOR AIR-POLLUTION DESIGN |
| 100 | 71 | 2762 | VENTILATION | MANURE HANDLING SYSTEMS AND ENVIRONMENTAL CONTROL FOR CONFINED DAIRY HOUSING KEYWORDS |
| 200 | 72 | 1880 | VIRUSES | EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS KEYWORDS AQUIFERS EFFECTS ANIMAL-WASTES |
| 700 | 69 | 2225 | VISCOSITY | AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON THE AGITATION AND REMOVAL O |
| 700 | 73 | 2379 | VISCOSITY | OXYGEN TRANSFER RELATIONSHIPS IN A POULTRY WASTE MIXED LIQUOR KEYWORDS WASTE-TREATMEN |

# KEYWORD INDEX

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|---|---|---|---|---|
| 200 | 73 | 2482 | VISCOSITY | HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE KEYWORDS HYDRAULIC-SYSTEMS ANIMAL-WASTES DES |
| 100 | 74 | 2775 | VISCOSITY | EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE KEYWORDS PHYSICAL-PROPERTIES EVALUATIO |
| 300 | 74 | 2217 | VITAMIN-A | COMPARISON OF SOYBEAN MEAL UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING |
| 100 | 48 | 2400 | VITAMIN-B12 | RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE KEYWORDS FARM-WAST |
| 100 | 61 | 2505 | VITAMIN-B12 | THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI |
| 600 | 74 | 2285 | VOLATILE-ACIDS | POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS KEYWORDS POULTRY WAST |
| 200 | 75 | 2689 | VOLATILE-COMPOUNDS | IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BIULDING AND MEASUR |
| 200 | 75 | 2690 | VOLATILE-COMPOUNDS | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR MEA |
| 100 | 74 | 2045 | VOLATILE-ORGANIC-A | CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN STORED DAIRY MANURE KEYWOR |
| 600 | 72 | 1993 | VOLATILE-SOLIDS | STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES KEYWORD |
| 300 | 74 | 2044 | VOLATILE-SOLIDS | LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY PRODUCTS KEYWORDS LIQ |
| 700 | 69 | 2181 | VOLATILE-SOLIDS | AEROBIC STORAGE OF DAIRY CATTLE MANURE KEYWORDS WASTE-STORAGE AEROBIC-CONDITIONS DAIR |
| 700 | 67 | 2234 | VOLATILE-SOLIDS | AEROBIC DIGESTION OF CATTLE WASTE KEYWORDS FARM-WASTES CATTLE WASTE-TREATMENT CHEMICA |
| 100 | 63 | 2581 | VOLATILE-SOLIDS | ANAEROBIC DIGESTION OF HOG WASTES KEYWORDS ANAEROBIC-DIGESTION SLUDGE-DIGESTION METHA |
| 300 | 68 | 1625 | VOLATILITY | TENTATIVE CRITERIA FOR DESIGN CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXID |
| 200 | 73 | 1789 | VOLATILITY | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
| 700 | 72 | 2321 | VOLATILITY | QUANTITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR KEYWORDS ODOR VOL |
| 400 | 73 | 1957 | VOLATILIZATION | AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA KEYWORDS AMMONIA WATER-POL |
| 100 | 74 | 2242 | VOLATILIZATION | NITROGEN LOSS FROM MANURE AS INFLUENCED BY MOISTURE AND TEMPERATURE KEYWORDS NITROGEN |
| 100 | 73 | 2249 | VOLATILIZATION | IDENTIFICATION OF ALIPHATIC AMINES VOLATILIZED FROM CATTLE FEEDYARD KEYWORDS FEEDLOT |
| 100 | 71 | 2424 | VOLATILIZATION | VOLATILIZATION OF NITROGEN CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS KEYWORDS FEEDL |
| 300 | 75 | 2507 | VOLATILIZATION | MANAGE MANURE FOR ITS VALUE KEYWORDS SOLID-WASTES LIQUID-WASTES CROP-RESPONSE ODOR |
| 200 | 75 | 2633 | VOLATILIZATION | TOTAL WASTE MANAGEMENT FOR A LARGE SWINE PRODUCTION FACILITY KEYWORDS COSTS SPRINKLER- |
| 300 | 74 | 2255 | VOLITALIZATION | ANIMAL WASTES AND FERTILIZERS AS POTENTIAL SOURCES OF NITRATE POLLUTION OF WATER KEYWO |
| 400 | 75 | 2341 | VOLUME | MOST FLUME FLOORS SHORT ON ENGINEERING KEYWORDS SAFETY-FACTOR FLOW-RATE WASTE-DILUTIO |
| 200 | 73 | 2487 | VOLUME | RETURNING ANIMAL WASTES TO THE LAND-EQUIPMENT CONSIDERATIONS KEYWORDS EQUIPMENT DESIG |
| 100 | 73 | 1637 | VOLUNTARY-INTAKE | HIGH FAT RATIONS FOR RUMINANTS II EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR T |
| 600 | 73 | 1616 | WARM-BARNS | WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS KEYWORDS CATTLE CONFINEMENT-PENS PERFORM |
| 400 | 72 | 1940 | WARM-WATER | WARM WATER STUDY KEYWORDS REGULATION FEEDS ALGAE FEEDLOTS GENERATING-PLANT WARM-WATER |
| 300 | 75 | 2339 | WASHINGTON | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 300 | 74 | 1627 | WASHINGTON-STATE-U | ANAEROBIC AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES KEYWORDS AEROBIC-TREATMENT A |
| 700 | 69 | 1734 | WASTELAGE | DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE KEYWORDS FEEDS RECYCLING WASTELAGE DIGEST |
| 200 | 75 | 2590 | WASTELAGE | ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUE |
| 100 | 69 | 1659 | WASTES | ULTIMATE DISPOSAL OF WASTES TO SOIL KEYWORDS WASTES ULTIMATE-DISPOSAL RECYCLING WASTE |
| 300 | 73 | 1785 | WASTES | NITROGENOUS COMPOUNDS IN THE ENVIRONMENT KEYWORDS FEEDLOTS WASTE-WATER-TREATMENT WATE |
| 200 | 63 | 2166 | WASTES | ODORS AND AIR POLLUTION KEYWORDS WASTES POULTRY AIR-POLLUTION ODOR ODOR-CONTROL ODOR- |
| 300 | 68 | 2220 | WASTES | SAMPLING BACTERIA IN A MOUNTAIN STREAM KEYWORDS SAMPLING BACTERIA INDICATORS WATER-P |
| 600 | 72 | 2106 | WASTEWATERS | EVALUATION OF METHODS FOR THE ANALYSIS OF PHYSICAL CHEMICAL AND BIOCHEMICAL PROPERTIES |
| 600 | 74 | 2081 | WASTEWATER | TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES KEYWORDS SOIL-PROFILE |
| 200 | 74 | 2151 | WASTEWATER | AGRICULTURAL POLLUTION CONTROL LABORATORY KEYWORDS BACTERIA HYDROGEN-SULFIDE METHANE |
| 300 | 72 | 2386 | WASTE | ANIMAL WASTE MANAGEMENT IN TEXAS TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE |
| 400 | 73 | 1812 | WASTE-ACCUMULATION | FEEDING VARIATIONS CAN AFFECT WASTE KEYWORDS FEEDS FEED-LOTS CONFINEMENT-PENS TEXAS C |
| 100 | 74 | 2082 | WASTE-ACCUMULATION | WASTE ACCUMULATION ON A SELECTED DAIRY CORRAL AND ITS EFFECT ON THE NITRATE AND SALT OF |
| 300 | 73 | 2096 | WASTE-ACCUMULATION | SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING KEYWORDS WASTE-DISPOSAL SLABS COSTS ODORS LA |
| 200 | 75 | 2614 | WASTE-ACCUMULATION | EVALUATION OF DAIRY BEEF AND SWINE WASTE HANDLING SYSTEMS KEYWORDS LIVESTOCK DAIRY-IND |
| 400 | 72 | 2306 | WASTE-ACCUMULATON | HOW NUTTING PRE-DRIES MANURE IN DEEP-PIT HOUS. KEYWORDS POULTRY DRYING MOISTURE-CONTEN |
| 200 | 74 | 2006 | WASTE-CHARACTERIST | CHARACTERIZATION OF WHITE LEGHORN MANURE KEYWORDS FEEDS MORTALITY MOISTURE-CONTENT WH |
| 200 | 74 | 1986 | WASTE-COLLECTION | DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS WASTE-DISPOSAL RE |
| 400 | 75 | 2575 | WASTE-COLLECTION | HE USES VALUABLE RUNOFF KEYWORDS AGRICULTURAL-RUNOFF DRAINAGE FEEDLOTS FERTILIZERS CO |
| 200 | 71 | 1933 | WASTE-CONTROL-ORDE | GUIDELINES FOR HANDLING LIQUID WASTE FROM FEEDLOTS KEYWORDS FEEDLOTS LIQUID-WASTES AG |
| 100 | 75 | 2422 | WASTE-DECOMPOSITIO | WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS |
| 600 | 74 | 1756 | WASTE-DILUTION | ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS KEYWORDS AGRICULTURAL-RUNOFF AN |
| 400 | 75 | 2341 | WASTE-DILUTION | MOST FLUME FLOORS SHORT ON ENGINEERING KEYWORDS SAFETY-FACTOR FLOW-RATE WASTE-DILUTIO |
| 300 | 74 | 1782 | WASTE-DISCHARGE | POLLUTION ASPECTS OF CATFISH PRODUCTION-REVIEW AND PROJECTIONS KEYWORDS FISH-FARMING |
| 300 | 74 | 1619 | WASTE-DISPOSAL | FERTILIZER VALUE OF DAIRY LOT MANURE KEYWORDS FERTILIZERS DAIRY-INDUSTRY CONFINEMENT- |
| 400 | 74 | 1630 | WASTE-DISPOSAL | MANURE AS A FUEL KEYWORDS FUELS MANURE WASTE-TREATMENT WASTE-DISPOSAL COMPOSTING AGRI |
| 400 | 73 | 1633 | WASTE-DISPOSAL | FAST FLUSH SYSTEM KEYWORDS FAST-FLUSH-SYSTEM CATTLE WASTE-TREATMENT WASTE-DISPOSAL FE |
| 400 | 71 | 1641 | WASTE-DISPOSAL | TEST SWINE WASTE DISPOSAL SYSTEMS KEYWORDS SWINE WASTE-DISPOSAL TESTING WATER-POLLUTI |
| 200 | 66 | 1644 | WASTE-DISPOSAL | TREATMENT OF ANIMAL WASTES AT THE GREENFIELD LABORATORIES OF ELI LILLY AND COMPANY KEY |
| 200 | 74 | 1649 | WASTE-DISPOSAL | COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE KEYWORDS MUNICIPAL-WASTES FEEDLOTS FARM-W |
| 700 | 66 | 1679 | WASTE-DISPOSAL | TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION KEYWORDS WAST |
| 100 | 73 | 1685 | WASTE-DISPOSAL | SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH |
| 200 | 64 | 1691 | WASTE-DISPOSAL | SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS POULTRY EXCRE |
| 200 | 64 | 1692 | WASTE-DISPOSAL | WASTE DISPOSAL CONCEPTS KEYWORDS WASTE-DISPOSAL EXCRETA POULTRY LAGOONS ANAEROBIC-DIG |
| 200 | 64 | 1693 | WASTE-DISPOSAL | PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL-AEROBIC STABILI |
| 200 | 64 | 1703 | WASTE-DISPOSAL | HEALTH ASPECTS OF POULTRY WASTE DISPOSAL KEYWORDS POULTRY WASTE-DISPOSAL PUBLIC-HEALTH |
| 200 | 64 | 1705 | WASTE-DISPOSAL | WHERE DO WO GO FROM HERE KEYWORDS POULTRY WASTE-DISPOSAL WATER-POLLUTION RESEARCH |
| 600 | 71 | 1727 | WASTE-DISPOSAL | ECONOMIC CONSIDERATIONS INVOLVED IN SELECTING TYPES OF CONFINEMENT AND WASTE DISPOSAL S |
| 300 | 71 | 1739 | WASTE-DISPOSAL | CATTLE FEEDLOT POLLUTION STUDY KEYWORDS WASTE-TREATMENT WASTE-DISPOSAL CATTLE FEEDLOT |
| 700 | 71 | 1742 | WASTE-DISPOSAL | A COMPARISON OF AN AERATED LAGOON AND IRRIGATION SYSTEM WITH A CONVENTIONAL SYSTEM FOR |
| 600 | 74 | 1751 | WASTE-DISPOSAL | CHEMICAL CHANGES IN SOILS USED FOR BEEF MANURE DISPOSAL KEYWORDS CATTLE WASTE-DISPOSAL |
| 400 | 74 | 1770 | WASTE-DISPOSAL | COSTS NOTED FOR SOLID AND LIQUID WASTE SYSTEM KEYWORDS WASTE-STORAGE WASTE-DISPOSAL LI |
| 300 | 68 | 1776 | WASTE-DISPOSAL | POLLUTION IMPLICATIONS OF ANIMAL WASTES-A FORWARD ORIENTED REVIEW KEYWORDS CATTLE HO |
| 600 | 67 | 1780 | WASTE-DISPOSAL | THE PROBLEM OF FARM ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL LIVESTOCK POULTRY C |
| 700 | 71 | 1791 | WASTE-DISPOSAL | PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM KE |
| 300 | | 1792 | WASTE-DISPOSAL | SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF |
| 100 | 71 | 1796 | WASTE-DISPOSAL | SLUDGE DISPOSAL-A CASE OF LIMITED ALTERNATIVES KEYWORDS SLUDGE-DISPOSAL ALTERNATIVES F |
| 400 | 74 | 1797 | WASTE-DISPOSAL | WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF KEYWORDS FARM-WASTES WASTE-DISPOSAL |
| 100 | 72 | 1798 | WASTE-DISPOSAL | EVALUATION OF ANAEROBIC LAGOON TREATING SWINE WASTES KEYWORDS LAGOONS ANAEROBIC-CONDI |
| 400 | 74 | 1799 | WASTE-DISPOSAL | FARM POLLUTION-HOW REGULATIONS AFFECT YOU KEYWORDS PERMITS REGULATION LIVESTOCK FARM-W |
| 300 | 72 | 1802 | WASTE-DISPOSAL | ENVIRONMENTAL ECONOMIC AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE M |
| 600 | 73 | 1803 | WASTE-DISPOSAL | FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE C |
| 400 | 72 | 1804 | WASTE-DISPOSAL | FEEDLOT DESIGN AND CONSTRUCTION KEYWORDS FEEDLOTS CONSTRUCTION DESIGN FACILITIES CATT |
| 200 | 70 | 1805 | WASTE-DISPOSAL | FEEDLOT WASTE MANAGEMENT SYSTEMS KEYWORDS FEEDLOTS WASTE-MANAGEMENT-SYSTEMS POLLUTANT |
| 100 | 73 | 1806 | WASTE-DISPOSAL | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 400 | 72 | 1807 | WASTE-DISPOSAL | CONFINEMENT PAYS IF WEATHER IS BAD KEYWORDS CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL |
| 400 | 74 | 1809 | WASTE-DISPOSAL | MANURE REFEEDING CUTS ODOR SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN KEYWORDS ELECTRIC |
| 400 | 74 | 1810 | WASTE-DISPOSAL | NO CHANGES IN FLY CONTROL FOR 1974 KEYWORDS PEST-CONTROL DAIRY-INDUSTRY FLY-CONTROL |
| 400 | 73 | 1811 | WASTE-DISPOSAL | AVERT RUNOFF POLLUTION KEYWORDS AGRICULTURAL-RUNOFF FEEDLOTS IRRIGATION EVAPORATION P |
| 300 | 70 | 1814 | WASTE-DISPOSAL | FEEDLOT POLLUTION KEYWORDS FEEDLOTS AIR-POLLUTION WATER-POLLUTION MONTANA REGULATION |
| 400 | 73 | 1817 | WASTE-DISPOSAL | FLUSH SYSTEM CUTS CONFINEMENT COSTS KEYWORDS CONFINEMENT-PENS CATTLE COSTS FLUSH-SYST |
| 400 | 72 | 1819 | WASTE-DISPOSAL | GE ENTERS MANURE RECYCLING RACE KEYWORDS MANURE FEEDLOTS RECYCLING FEEDS PROTEINS WA |
| 400 | 73 | 1820 | WASTE-DISPOSAL | GRASS FILTER SYSTEMS ANOTHER NEW RUNOFF CONTROL METHOD KEYWORDS WASTE-TREATMENT WASTE- |
| 100 | 74 | 1821 | WASTE-DISPOSAL | IRRIGATION OF PERENNIAL FORAGE CROPS WITH FEEDLOT RUNOFF KEYWORDS IRRIGATION AGRICULTU |
| 300 | 73 | 1825 | WASTE-DISPOSAL | AREA NEEDED FOR LAND DISPOSAL OF BEEF AND SWINE WASTES KEYWORDS CATTLE SWINE WASTE-DIS |
| 400 | 74 | 1827 | WASTE-DISPOSAL | THIN BED DRYING OF POULTRY MANURE KEYWORDS MANURE DRYING POULTRY CALIFORNIA ODOR AER |
| 100 | 73 | 1833 | WASTE-DISPOSAL | AGRICULTURAL WASTES KEYWORDS LIVESTOCK AGRICULTURAL-WASTES CHEMICAL-PROPERTIES PHYSIC |
| 300 | 73 | 1835 | WASTE-DISPOSAL | STRUCTURES AND ENVIRONMENT HANDBOOK KEYWORDS PLANNING ENVIRONMENT WASTE-DISPOSAL DESI |
| 400 | 73 | 1859 | WASTE-DISPOSAL | PROCESS CONVERTS ANIMAL WASTES TO OIL KEYWORDS FARM-WASTES OIL FEEDLOTS ENERGY WASTE- |
| 100 | 71 | 1872 | WASTE-DISPOSAL | AGRICULTURE THE SEEDS OF A PROBLEM KEYWORDS AGRICULTURE FARM-WASTES FORESTRY WASTE-DI |

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200 71 1882  WASTE-DISPOSAL     RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT-THE  ROLE OF LAND AND SOIL
400 74 1883  WASTE-DISPOSAL     CUSTOM CATTLE FEEDING MOVES TO THE SOUTHEAST  KEYWORDS CATTLE SOUTHEAST-U-S WASTE-DISPO
600 70 1896  WASTE-DISPOSAL     WATER QUALITY AND WASTE DISPOSAL IN MONTANA  KEYWORDS WATER-QUALITY WASTE-DISPOSAL MONT
300 66 1897  WASTE-DISPOSAL     CHICKEN MANURE ITS PRODUCTION VALUE PRESERVATION AND DISPOSITION  KEYWORDS  POULTRY CHI
400 71 1898  WASTE-DISPOSAL     ANIMAL WASTE DISPOSAL  KEYWORDS  ANIMAL-WASTES WASTE-DISPOSAL CANADA AEROBIC-TREATMENT
200 71 1925  WASTE-DISPOSAL     SOIL CONSERVATION SERVICE TEXAS TECH UNIVERSITY WORKSHOP COMMITTEE ON FEEDLOT WASTE  AF
600 74 1960  WASTE-DISPOSAL     ERODIBILITY FACTOR OF BEEF CATTLE MANURE  KEYWORDS  CATTLE  FEEDLOTS SOLID-WASTES WASTE
200 71 1964  WASTE-DISPOSAL     MOVEMENT OF GROUND WATER  KEYWORDS  GROUNDWATER-POLLUTION MOVEMENT WASTE-DISPOSAL ANIMA
200 71 1969  WASTE-DISPOSAL     WHAT OUR MILK MARKETS REQUIRE  KEYWORDS  MILK WASTE-DISPOSAL REGULATION DAIRY-INDUSTRY
200 71 1970  WASTE-DISPOSAL     FARM ANIMAL WASTE MANAGEMENT-WHAT OUR MILK MARKET REQUIRES  KEYWORDS  MILK ANIMAL-WASTE
200 71 1971  WASTE-DISPOSAL     CONTROLLING BARNYARD RUNOFF KEYWORDS  WASTE-DISPOSAL WISCONSIN FEEDLOTS RUNOFF-CONTROL
200 69 1981  WASTE-DISPOSAL     DEHYDRATION AN ECONOMICAL SOLUTION TO POULTRY MANURE PROBLEMS  KEYWORDS  DEHYDRATION EC
200 74 1986  WASTE-DISPOSAL     DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES KEYWORDS  WASTE-DISPOSAL OF
200 74 2013  WASTE-DISPOSAL     ENERGY AND MONETARY COSTS FOR THE BEEF CATTLE WASTE DISPOSAL SYSTEMS  KEYWORDS  ENERGY
200 74 2034  WASTE-DISPOSAL     SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES KEYWORDS  DAIRY-INDUSTRY SOIL
300 74 2042  WASTE-DISPOSAL     THE IMPACT ON DAIRY FARM ORGANIZATION OF ALTERNATIVE MANURE DISPOSAL SYSTEMS A METHOD O
400 72 2046  WASTE-DISPOSAL     BREAKTHROUGH IN THE FIGHT AGAINST POLLUTION  KEYWORDS THERMOPHILIC-BACTERIA WASTE-TREAT
100 73 2051  WASTE-DISPOSAL     BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS  KEYWORDS  TERRACES FEEDLOTS DESIGN WA
300 72 2054  WASTE-DISPOSAL     PROFITABLE USE OF POULTRY MANURE  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL POULTRY NUTR
100 72 2063  WASTE-DISPOSAL     COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE  KEYWORDS  BURNING
600 74 2065  WASTE-DISPOSAL     NEW IRRIGATION CAN BE USED TO HANDLE MANURE  KEYWORDS IRRIGATION WASTE-DISPOSAL COSTS D
600 73 2067  WASTE-DISPOSAL     DRIED POULTRY MANURE UTILIZATION  KEYWORDS  RECYCLING POULTRY MANAGEMENT WATER-POLLUTIO
300 73 2076  WASTE-DISPOSAL     BEEF FEEDLOTS-A POLLUTION PROBLEM  KEYWORDS  FEEDLOTS MANAGEMENT WATER-POLLUTION AIR-PO
300 72 2080  WASTE-DISPOSAL     ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS  KEYWORDS  LIQUID-WAST
100 71 2092  WASTE-DISPOSAL     FARM EFFLUENT-ELECTRICAL DISPOSAL METHODS  KEYWORDS EFFLUENTS FARM-WASTES SUSPENDED-SOL
300 73 2096  WASTE-DISPOSAL     SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING  KEYWORDS  WASTE-DISPOSAL SLABS COSTS DOORS LA
600 73 2098  WASTE-DISPOSAL     THROW MILK WASTE RIGHT  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL SEWAGE LOUISIANA LAGOO
600 73 2103  WASTE-DISPOSAL     SLAB VS SLAT-AN EXPERT S OPINION  KEYWORDS  CONFINEMENT-PENS WASTE-DISPOSAL DESIGN ARIZ
300 72 2105  WASTE-DISPOSAL     LAGOONS FOR ANIMAL WASTE DISPOSAL  KEYWORDS  WASTE-DISPOSAL LAGOONS DESIGN LOADING LAGO
300 73 2121  WASTE-DISPOSAL     EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTE
600 72 2122  WASTE-DISPOSAL     CONFINEMENT HOUSING SYSTEMS FOR SOWS  KEYWORDS  CONFINEMENT-PENS BREEDING WASTE-DISPOSA
600 73 2124  WASTE-DISPOSAL     DESIGN AND OPERATION OF A FEEDLOT RUNOFF DISPOSAL SYSTEM-A  CASE STUDY  KEYWORDS  DESIG
100 74 2126  WASTE-DISPOSAL     AGRICULTURAL WASTES  KEYWORDS  LIVESTOCK PROPERTIES WASTE-TREATMENT REFEEDING LAND-DISP
900 74 2132  WASTE-DISPOSAL     AGRICULTURAL WASTE MANAGEMENT-PROBLEMS PROCESSES AND APPROACHES  KEYWORDS  WASTE-TREATM
200 71 2133  WASTE-DISPOSAL     ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT-TECHNOLOGY AND ECONOMICS PHASE I  KEYW
200 63 2153  WASTE-DISPOSAL     NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT KEYWORDS  POULTRY WASTE-TREATME
200 63 2156  WASTE-DISPOSAL     MANURE DISPOSAL LAGOONS  KEYWORDS  LAGOONS WASTE-TREATMENT  WASTE-DISPOSAL CHEMICAL-PRO
200 63 2157  WASTE-DISPOSAL     INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL  KEYWORDS  LAGOONS POULTRY WASTE-DISPOSAL OD
200 63 2165  WASTE-DISPOSAL     UTILIZATION AND DISPOSAL OF POULTRY MANURE  KEYWORDS  POULTRY WASTE-DISPOSAL AERATION M
400 72 2167  WASTE-DISPOSAL     PLANNING FEEDLOT WASTE DISPOSAL  KEYWORDS  PLANNING FEEDLOTS WASTE-DISPOSAL WASTE-STORA
600 75 2171  WASTE-DISPOSAL     SLICK DISPOSAL SETUP DAIRYMAN DESIGNED IT  KEYWORDS  WASTE-DISPOSAL LAGOONS WATER DAIRY
600 69 2175  WASTE-DISPOSAL     THE DESIGN AND OPERATION OF AN OPEN FRONT SLOTTED FLOOR BEEF CONFINEMENT BUILDING  KEYW
600 69 2179  WASTE-DISPOSAL     THE EFFECT OF FARM WASTES ON THE POLLUTION OF NATURAL WATER  KEYWORDS  FARM-WASTES WATE
100 72 2190  WASTE-DISPOSAL     HANDLING MILKING PARLOR WASTE  KEYWORDS  DAIRY-INDUSTRY FARM-WASTES CATTLE WASTE-TREATM
600    2191  WASTE-DISPOSAL     NEW EGGMEN ARE SOLVING THE ECOLOGY PROBLEM  KEYWORDS  POULTRY ECOLOGY WASTE-STORAGE WAS
100 72 2193  WASTE-DISPOSAL     TAKING CARE OF WASTES FROM THE TROUT FARM  KEYWORDS  FISH-HATCHERIES TROUT WATER-POLLUT
600 64 2201  WASTE-DISPOSAL     HOW ARE LAGOONS WORKING ON HOG FARMS  KEYWORDS  LAGOONS DESIGN WASTE-DISPOSAL CONFINEME
600 74 2202  WASTE-DISPOSAL     NO PEN CLEANING COSTS  KEYWORDS  CONFINEMENT-PENS CATTLE KANSAS WASTE-DISPOSAL LAGOONS
600 74 2203  WASTE-DISPOSAL     NUISANCE LAWSUITS-NEIGHBOR VS STOCKMEN  KEYWORDS  LEGAL-ASPECTS WASTE-TREATMENT WASTE-D
100 74 2209  WASTE-DISPOSAL     AGRICULTURAL WASTE MANAGEMENT  KEYWORDS  WASTE-TREATMENT WASTE-DISPOSAL REGULATION WATE
700 63 2233  WASTE-DISPOSAL     CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE  KEYWORDS  FARM-WASTES HOGS ANAE
600 73 2245  WASTE-DISPOSAL     GROUNDWATER QUALITY BENEATH A MANURE DISPOSAL AREA KEYWORDS  WASTE-DISPOSAL NUTRIENTS N
600 68 2247  WASTE-DISPOSAL     ANIMAL WASTE DISPOSAL METHODS-PRESENT AND FUTURE  KEYWORDS  ANIMAL-WASTES WASTE-DISPOSA
800 72 2261  WASTE-DISPOSAL     DISPOSAL OF FARM ANIMAL WASTES THROUGH THE SOIL  KEYWORDS WASTE-DISPOSAL CATTLE DAIRY-I
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| 300 | 74 | 1783 | WATER-REUSE | QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE P |
| 600 | 74 | 1749 | WATER-SAMPLING | A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH PONDS KEYWORDS EFFLUENT F |
| 300 | 74 | 1678 | WATER-SUPPLY | LOCATING A NEW FEEDLOT KEYWORDS FEEDLOTS SITE-SELECTION WATER-POLLUTION LIVESTOCK REG |
| 600 | 74 | 2081 | WATER-TABLE | TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES KEYWORDS SOIL-PROFILE |
| 300 | 68 | 1776 | WATER-TREATMENT | POLLUTION IMPLICATIONS OF ANIMAL WASTES-A FORWARD ORIENTED REVIEW KEYWORDS CATTLE HO |
| 300 | 71 | 2133 | WATER-UTILIZATION | ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT-TECHNOLOGY AND ECONOMICS PHASE I KEYW |
| 300 | 72 | 2105 | WATER-VOLUMES | LAGOONS FOR ANIMAL WASTE DISPOSAL KEYWORDS WASTE-DISPOSAL LAGOONS DESIGN LOADING LAGO |
| 300 | 73 | 2355 | WAUKEGAN-SILT-LOAM | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 600 | 74 | 2356 | WAUKEGAN-SILT-LOAM | SWINE WASTE MANAGEMENT KEYWORDS CROP-RESPONSE CORN FERTILIZERS LIQUID-WASTES PESTICID |
| 100 | 75 | 2422 | WEATHERING | WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS |
| 400 | 72 | 1807 | WEATHER | CONFINEMENT PAYS IF WEATHER IS BAD KEYWORDS CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL |
| 100 | 71 | 2787 | WEATHER | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 200 | 73 | 1648 | WEATHER-DATA | ODOR INTENSITIES AT CATTLE FEEDLOTS KEYWORDS ODOR FEEDLOTS CATTLE AIR-POLLUTION AGRIC |
| 200 | 74 | 2030 | WEED-CONTROL | CROP AND HAY LAND DISPOSAL AREAS FOR LIVESTOCK WASTES KEYWORDS CROP-RESPONSE AGRICULT |
| 300 | 72 | 2374 | WEIGHTS | INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF |
| 400 | 75 | 2349 | WEIGHT | RECYCLING POULTRY LITTER AS SILAGE KEYWORDS RECYCLING SILAGE CATTLE WEIGHT TASTE POUL |
| 100 | 74 | 1855 | WEIRS | A ROTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER KEYWORDS SOLID-WAST |
| 200 | 64 | 2182 | WELLS | NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI KEYWORDS NITRATES NITRITES N |
| 300 | 75 | 2339 | WELLS | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 400 | 74 | 1917 | WESTERN-CORNBELT | DO FLUMES REALLY WORK KEYWORDS FLUMES PERFORMANCE CONFINEMENT-PENS COSTS FLUSHING WES |
| 200 | 70 | 2396 | WEST-VIRGINIA | AN ASSESSMENT OF THE AGRICULTURAL AND PROCESSING WASTE PROBLEMS AND CONTROL IN WEST VIR |
| 300 | 74 | 1860 | WETLANDS | ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NONPOINT SOURCES KEYWORDS NUTRIENTS EUTROPH |
| 100 | 74 | 2097 | WET-SCREENING | SIZE DISTRIBUTION AND NUTRITIONAL VALUE OF SWINE MANURE SEPARATES KEYWORDS NUTRIENTS |
| 200 | 74 | 2006 | WHITE-LEGHORNS | CHARACTERIZATION OF WHITE LEGHORN MANURE KEYWORDS FEEDS MORTALITY MOISTURE-CONTENT WH |
| 400 | 73 | 2416 | WINDROWS | POULTRY MANURE COMPOSTING KEYWORDS AERATION FORCED-DRYING THERMOPHILIC-BACTERIA MOIST |
| 200 | 75 | 2727 | WINDROW-TECHNIQUE | COMPOSTING SWINE WASTE KEYWORDS YIELDS COMPOSTING SWINE WINDROW-TECHNIQUE BULKING-MAT |
| 300 | 73 | 1617 | WIND | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 300 | 73 | 1617 | WIND-DIRECTION | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 200 | 75 | 2586 | WIND-DIRECTION | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS BA |
| 300 | 73 | 1915 | WIND-EROSION | METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURC |
| 400 | 75 | 2346 | WIND-EROSION | CONSEQUENCES OF WASTE DISPOSAL ON LAND KEYWORDS WASTE-DISPOSAL ORGANIC-WASTES SEWAGE- |
| 200 | 74 | 2465 | WIND-POSITION | NEW FLUSH FLUME SYSTEM WITH DEEP LAGOON KEYWORDS LAGOONS ODOR FEEDLOTS CONFINEMENT-P |
| 300 | 73 | 1617 | WIND-VELOCITY | PREVAILING WINDS IN FEEDLOT SITE SELECTION KEYWORDS FEEDLOTS SITE-SELECTION WIND ODOR |
| 200 | 75 | 2586 | WIND-VELOCITY | AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE KEYWORDS BA |
| 300 | 72 | 2090 | WINTERKILLS | EUTROPHICATION IN THE GREAT PLAINS KEYWORDS EUTROPHICATION GREAT-PLAINS WATER-POLLUTI |
| 400 | 72 | 1807 | WINTER | CONFINEMENT PAYS IF WEATHER IS BAD KEYWORDS CONFINEMENT-PENS COSTS WEATHER ODOR FEEDL |
| 100 | 71 | 1902 | WINTER | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER BROILERS MANURE COMPOSTI |
| 100 | 74 | 2069 | WINTER | WINTER OPERATION OF A MODIFIED OPEN FRONT FINISHING HOUSE FOR SWINE KEYWORDS WINTER D |
| 100 | 75 | 2456 | WINTER | WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSE FLIES IN POULTRY MANURE KEY |
| 200 | 75 | 2672 | WINTER | NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS KEYWORDS WINTER AGRICUL |
| 100 | 71 | 2787 | WINTER | WINTER HIGH RATE COMPOSTING OF BROILER MANURE KEYWORDS WINTER FARM-WASTES WASTE-TREATM |
| 400 | 73 | 1634 | WISCONSIN | HE SOLVED HIS MANURE HANDLING PROBLEM KEYWORDS WASTE-HANDLING DAIRY-INDUSTRY AGRICULT |
| 200 | 71 | 1962 | WISCONSIN | PROCEEDINGS OF CONFERENCES ON FARM ANIMAL WASTES NITRATES AND PHOSPHATES IN RURAL WISCO |
| 200 | 71 | 1965 | WISCONSIN | THE ROLE OF THE WISCONSIN DEPARTMENT OF AGRICULTURE IN AGRICULTURAL POLLUTION PREVENTIO |
| 200 | 71 | 1967 | WISCONSIN | PHOSPHORUS IN OUR ENVIRONMENT KEYWORDS PHOSPHORUS FERTILIZERS SURFACE-WATERS ENVIRONM |
| 200 | 71 | 1970 | WISCONSIN | FARM ANIMAL WASTE MANAGEMENT-WHAT OUR MILK MARKET REQUIRES KEYWORDS MILK ANIMAL-WASTE |
| 200 | 71 | 1971 | WISCONSIN | CONTROLLING BARNYARD RUNOFF KEYWORDS WASTE-DISPOSAL WISCONSIN FEEDLOTS RUNOFF-CONTROL |
| 200 | 71 | 1977 | WISCONSIN | UNIVERSITY OF WISCONSIN RESEARCH ON MANURE HANDLING KEYWORDS WISCONSIN RESEARCH-AND-D |
| 400 | 75 | 2214 | WISCONSIN | LOW COST MANURE BASINS WORK IN WISCONSIN KEYWORDS WASTE-STORAGE WISCONSIN BASINS COSTS |
| 300 | 74 | 2215 | WISCONSIN | A COMPARISON OF SOLID AND LIQUID MANURE STORAGE SYSTEMS KEYWORDS WASTE-STORAGE SOLID-W |
| 100 | 70 | 2381 | WISCONSIN | COMPARISON OF INORGANIC NITROGEN CONTENTS OF UNDISTURBED CULTIVATED AND BARNYARD SOIL P |
| 200 | 64 | 2566 | WISCONSIN | NEWER ASPECTS IN TREATMENT OF PACKING HOUSE AND FEEDLOT WASTES KEYWORDS WASTE-TREATME |
| 400 | 72 | 2573 | WISCONSIN | A LIVESTOCKMANS GUIDE TO POLLUTION LAWS KEYWORDS LEGAL-ASPECTS REGULATION FEEDLOTS WAT |
| 200 | 75 | 2603 | WISCONSIN | THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES KEYWORDS REGULATION |
| 200 | 75 | 2615 | WISCONSIN | LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES- EARTHEN BASINS KEYWORDS DAIRY- |
| 200 | 75 | 2626 | WISCONSIN | MANURE PONDS FOR MINIMIZING POLLUTION KEYWORDS WISCONSIN DAIRY-INDUSTRY COSTS DESIGN |
| 200 | 72 | 2361 | WOOD-SHAVINGS | THE FATE OF NITROGEN AND PHOSPHORUS IN AN OXIDATION DITCH TREATING SWINE WASTES KEYWOR |
| 600 | 74 | 2072 | WOOD-WASTES | PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS KEYWORDS FUELS ENERGY DESIGN PYR |
| 300 | 75 | 2339 | WYOMING | GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES KEYWORDS GROUNDWAT |
| 100 | 72 | 1788 | YEASTS | MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES KEYWORDS FEEDLOTS CATTLE A |
| 200 | 73 | 1789 | YEASTS | SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES KEYWORDS SWINE ODOR FEEDS ADDITIVES SAM |
| 200 | 74 | 2459 | YEASTS | FERMENTATION AS A FEED PRODUCTION METHOD KEYWORDS FERMENTATION FEEDS RECYCLING BACTERI |
| 100 | 61 | 2505 | YEASTS | THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS KEYWORDS BACTERIA MOLDS YEASTS LI |
| 100 | 71 | 2767 | YEASTS | BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY KEYWORDS ANIMAL-WASTES-WILDL |
| 100 | 73 | 1806 | YIELDS | FEEDLOT MANURE A POTENTIALLY VALUABLE MATERIAL KEYWORDS FEEDLOTS MANURE WASTE-TREATMEN |
| 600 | 72 | 1893 | YIELDS | LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD |
| 100 | 74 | 2064 | YIELDS | CORN SILAGE YIELD AND SOIL CHEMICAL PROPERTIES AS AFFECTED BY CATTLE FEEDLOT MANURE KE |
| 400 | 74 | 2070 | YIELDS | USE OF ANIMAL WASTES AS A SOIL AMENDMENT KEYWORDS ANIMAL-WASTES FERTILIZERS CATTLE NU |
| 100 | 74 | 2340 | YIELDS | RESULTS FROM EXPERIMENTS MEASURING THE EFFECTS OF LARGE AMOUNTS OF FERTILIZER AND OF FA |
| 300 | 65 | 2377 | YIELDS | BROILER LITTER AS A FERTILIZER KEYWORDS FERTILIZERS NUTRIENTS BROILER-LITTER LAND-DIS |
| 100 | 65 | 2423 | YIELDS | VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL KEYWORDS NUTRIENTS NITROGEN PHOSPHORUS |
| 200 | 73 | 2442 | YIELDS | DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND KEYWORDS FARM-WASTES LI |
| 200 | 75 | 2667 | YIELDS | THE YIELD RESPONSE OF GRASS TO AEROBICALLY STABILIZED SWINE WASTE KEYWORDS CROP-RESPO |
| 200 | 75 | 2727 | YIELDS | COMPOSTING SWINE WASTE KEYWORDS YIELDS COMPOSTING SWINE WINDROW-TECHNIQUE BULKING-MAT |
| 200 | 75 | 2749 | YIELDS | COMPARISON OF LINT COTTON FIELDS FOLLOWING APPLICATIONS OF BEEF CATTLE WASTES AND COMM |
| 300 | 74 | 1619 | YIELD | FERTILIZER VALUE OF DAIRY LOT MANURE KEYWORDS FERTILIZERS DAIRY-INDUSTRY CONFINEMENT- |
| 100 | 73 | 1800 | YIELD | EFFECTS OF CONTINUOUS ZEA MAYS L MANURING AND NITROGEN FERTILIZATION ON YIELD AND PRO |
| 300 | 73 | 2208 | YIELD | USE OF CATTLE FEEDLOT RUNOFF IN CROP PRODUCTION KEYWORDS FEEDLOTS CATTLE AGRICULTURAL- |
| 300 | 72 | 2089 | ZERO-DISCHARGE | ANIMAL WASTE-REGULATORY CONSIDERATIONS KEYWORDS WATER-POLLUTION REGULATION FEEDLOTS P |
| 200 | 74 | 2467 | ZERO-DISCHARGE | LEGAL ASPECTS OF WASTE POLLUTION LAWS KEYWORDS LEGAL-ASPECTS FEEDLOTS WATER-POLLUTION |
| 200 | 75 | 2633 | ZERO-DISCHARGE | TOTAL WASTE MANAGEMENT FOR A LARGE SWINE PRODUCTION FACILITY KEYWORDS COSTS SPRINKLER- |

# KEYWORD INDEX

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700 69 1690  ZETA-POTENTIAL     ZETA POTENTIAL OF CCLOIDAL SUSPENSIONS FROM A BEEF CATJLE FEEDLCT SURFACE  KEYWORDS  ZE
300 72 2371  ZINC               MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS  KEYWORDS FEEDS MINNESOTA ANALYSES PHOS
100 75 2490  ZINC               EFFECTS OF BEEF FEEDLOT MANURE AND LAGOON WATER ON IRON ZINC MANGANESE AND COPPER CONTE
300 74 1678  ZCNING             LOCATING A NEW FEEDLCT  KEYWORDS  FEEDLOTS SITE-SELECTION WATER-POLLUTION LIVESTOCK REG
300 73 1733  ZCNING             THE ECCNOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA KEYWORDS  FEEDLOTS CATTLE ZONIN
400 65 2037  ZCNING             MANURE ODORS CAN LAND YCU IN COURT  KEYWORDS  ODOR LEGAL-ASPECTS URBAN-DEVELOPMENT ZONI
100 67 2192  ZONING             COMMERCIAL FEEDLOTS-NUISANCE ZONING AND REGULATIJN  KEYWORDS  FEEDLOTS NUISANCE ZONING
200 69 2488  ZCNING             PERSONAL SIDELIGHTS AND OBSERVATIONS CF THE HBI TRIAL KEYWORDS  ODOR LAGOONS ZONING LAW
400 72 2554  ZCONOSES           ENVIRONMENTAL HEALTH AND ANIMAL WASTES  KEYWORDS  ENVIRONMENTAL-EFFECTS ANIMAL-WASTES Z
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# SECTION V

## ANIMAL INFORMATION CATEGORY INDEX

### CATEGORIES OF ANIMAL INFORMATION

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| | 5. Odor |
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| F. General | 1. Economics |
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# ANIMAL INFORMATION CATEGORY INDEX

[illegible]

# SECTION VI

# ABSTRACTS

## 1615 - B1 400

## WILL A CONFINEMENT BARN PAY?

Beef, Vol. 9, No. 8, p. 3-8, April, 1973. 4 fig.

Descriptors: *Confinement pens, *Economics, *Feedlots, Cattle, Costs, Farm wastes.
Identifiers: *Open lots.

Much controversy has arisen among beef producers over the economics of confinement feeding. Some sa- that open lots are cheaper and and just as good, while others insist that confinement is more profitable. The proponents of the open lot say that open lots are as productive as confinement if they are designed properly and not overloaded. In a comparison between confinement and open lot we see that: (1) Feeding time is shorter in confinement; (2) The handling of the cattle is easier inside; (3) It is a toss up between the manure handling; (4) The open lot is much cheaper to build; (5) Surprisingly, it takes less upkeep to keep the building in good shape than it does the outside; (6) Insurance is cheaper for the outside arrangement; (7) It takes less labor inside; (8) Health is better inside; (9) Marketing programs can be planned better inside; and (10) Space is better conserved with a building than with an open lot. Both systems have advantages and disadvantages, but the success is dependent on individual needs and circumstances. (Russell-East Central).

## 1616 - B1 600

## WASTE MANAGEMENT IN FIVE BEEF HOUSING SYSTEMS

West Central Experiment Station, University of Minnesota, Morris.
L. K. Linder, K. A. Jordan, R. E. Smith, H. E. Hanke, et. al.
Presented at 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, Paper No. 73-4542, 12 p. 15 tab.

Descriptors: Waste treatment, *Cattle, *Confinement pens, *Performance, Farm wastes, Waste storage.
Identifiers: *Waste management, *Housing systems, Cold barns, Warm barns.

Production data was gathered in five beef housing systems. The data concerned animal wastes, environments, average daily gain, and feed efficiency for 680 head of 425 pound hereford steers fed over a two-year period. Housing systems were compared. It was found that there was a manure build-up on top of the slats in the cold slat barn during extreme winter weather. The manure pit froze in the cold barn soon after the outside temperature dropped below 32 degrees. Before pumping the pits, it was necessary to agitate 6 to 8 hours to prevent solids from building up on the pit floor. It was also found that an 8 ft. deep pit was adequate for feeding out 425 pound steers to market weight. The sloping floors in the scrape barn aided movement of waste into the scrape ally. It was concluded that the environmental modification provided by the heavily insulated warm barn might be superfluous. (Russell-East Central).

## 1617 - A5, B1 300

## PREVAILING WINDS IN FEEDLOT SITE SELECTION

Texas Agricultural Extension Service, Texas A & M University, College Station.
J. M. Sweeten.
Prepared for publication by Regional Extension Project for Feedlot Waste Management through the Great Plains Extension Feedlot Committee, July 9, 1973, 6 p. 3 fig.

Descriptors: *Feedlots, *Sites, *Wind, *Odor, Precipitation (Atmospheric), Wind velocity, Cattle.
Identifiers: *Site selection, Climatic patterns, Wind direction, Buffer zone.

Confined feeding of cattle in feedlots inevitably leads to the production of odor. Consequently, the most important element of a feedlot odor abatement consists of judicious site selection, which involves a study of local climatic factors to minimize the probability of odor drift into nearby population centers or closest neighbors in the direction of least probability of wind occurance. The optimum direction can be determined from published "wind rose" diagrams or from tabular wind direction data. An alternative objective in feedlot site selection, where sufficient data is available, is to minimize the probability of both a rainfall event and a specified wind direction occurring simultaneously. If feedlot odors are minimized during the most critical periods of adverse moisture and temperature, the wind speed factor is probably less important than wind direction considerations. (Russell-East Central).

## 1618 - A9, E3 400

## THEY BEAT THE HIGH COST OF PROTEIN WITH PLS

B. Johnson.
Progressive Farmer, Vol. 88, No. 11, p. 44-45, November, 1973. 2 fig.

Descriptors: *Costs, *Proteins, *Feeds, *Poultry, *Litter, *Silage, Cattle, Performance, Recycling, Waste disposal.

Tests are being made by Graham farm in Lexington, on a new kind of feed for dairy cattle called Poultry Litter Silage (PLS). The Grahams, using broiler litter given them from their neighbors, feed heifers and steers proteins that cost about one-twentieth as much as soybean meal. Here's how they figure it. Soybean meal with 39% disegtible protein sells for $300 a ton or 39 cents per pound (digestible). PLS is 14% digestible and costs $5 a ton. This is 2 cents per pound of digestible protein. Making this new feed is an art which must be carefully tested to assure safety. Cattle fed PLS gained weight satisfactorily and calved with no ill effects. Quality and taste of the meat seem to be good. Since the FDA doesn't sanction the feeding of poultry manure to other animals, cattle owners are liable if any harmful residues or contaminants can be traced back to their feeding operations. With PLS costing only one-twentieth of soybean meal cost, the Grahams, and many others believe the present evidence makes the risk of feeding PLS worth taking. (Cameron-East Central).

## 1619 - B3, E3 300

## FERTILIZER VALUE OF DAIRY LOT MANURE

J. M. Rakes, Q. Hornsby, and G. Barr.
Arkansas Farm Research, Vol. 23, No. 1, p. 8, January-February, 1974. 2 tab.

Descriptors: *Fertilizers, *Dairy industry, *Feed lots, *Farm wastes, *Waste disposal, Sampling, Analysis, Chemical properties, Nutrients, Forage grasses.
Identifiers: *Manure, Yield.

A study was undertaken at the Maine Experiment Station utilizing dairy lot manure as fertilizer. Two methods of manure handling were compared: scraping the manure into a pile and loading with a front-mounted tractor loader, or loading from a concrete ramp. Fresh dairy lot manure was applied at two rates of wet material—10 tons versus 100 tons per acre—on 1 acre plots in a field. The material was incorporated into the soil, and Boone orchardgrass and Victoria alfalfa were sown in the fall. Three types of soil were represented in the field. Yields were recorded and proximate analyses were made of the forage produced. Yield was consistently higher with the high level of manure application in all three cuttings. The data from this study suggest that, if cattle wastes are available, increased yields can be obtained by a high rate of application, balanced with limited commercial fertilizer. (Cartmell-East Central).

## 1620 - B1 300

## PROTOTYPE OF A BROILER CAGE SYSTEM

L. D. Andrews, G. S. Nelson, and G. C. Harris, Jr.
Arkansas Farm Research, Vol. 22, No. 1, p. 9, January-February, 1973. 3 fig.

Descriptors: *Farm wastes, *Poultry, Performance.
Identifiers: *Cage system, *Broilers, Cross auger, Feather follicles, Dropping boards.

Interest in caged broiler housing has been growing for several reasons: (1) the broilers may be removed from cages to a transport truck with a minimum of manual labor; (2) more broilers can be reared in a given space; (3) no litter is required; (4) manure is more easily removed; (5) less clean-up is needed between growouts; (6) heating costs are lower; (7) debeaking may not be necessary; (8) there is less bruising by catching crews; and (9) feed conversion and weight gain may be improved. Also, the growth rate of caged broilers is comparable to that of floor-reared birds. Within this four-tiered cage system is an automated feeding system, heating cables, and fans and scrapers which remove manure from the dropping boards beneath the cages. The manure is removed from the building by a cross auger. Among disadvantages are brittle bones, infected feather follicles, breast blisters, a high investment cost, and difficulty in observing birds in the cages. Finding a way to reduce these defects is the next step in perfecting caged broiler production. (Russell-East Central).

## 1621 - A5, A6, B1 100

## SOLUTIONS FOR FEEDLOT ODOR CONTROL PROBLEMS—A CRITICAL REVIEW

Office of Engineering Analysis Control Systems National Environmental Research Center, Research Triangle Park, North Carolina.
R. M. Bethea.
Journal of the Air Pollution Control Association, Vol. 22, No. 10, p. 675-773, October, 1972. 1 tab, 52 ref.

Descriptors: *Feed lots, *Odor, *Control, *Air pollution, *Farm wastes, *Waste treatment, Poultry, Hogs, Cattle, Livestock, Management, Costs, Feeds, Recycling, Oxidation, Analysis Measurement.
Identifiers: Refeeding, Ozonation Incineration, Gas washing and scrubbing.

This critical review begins with a description of the air pollution and odor control problems associated with animal feedlots and poultry houses. A brief description is given for dairy odors, poultry odors, swine odors, and cattle odors. Prevention of the release of odoriferous compounds would be the most efficacious long-range solution to agricultural odor control problems. The elimination of odors by incorporating humic acid into the feed ration appears to offer a promising possibility as a control technique for cattle, swine, and sheep feeding operations. Other methods of odor control that are discussed in detail with comparative cost and effectiveness data are: odor reduction by recycle feeding, odor reduction resulting from improved waste handling procedures, odor control by chemical reaction, odor control by ozonoation, odor control by gas washing and scrubbing, and odor elimination by thermal and catalytic incineration. Discussion and recommendations for future research are presented. (Cartmell-East Central).

## 1622 - D2, E3 300

## THE DISPOSAL OF CATTLE FEEDLOT WASTES BY PYROLYSIS

Midwest Research Institute, 425 Volker Boulevard, Kansas City, Missouri.
W. Garner and I. C. Smith.
Environmental Protection Agency Report Number, EPA-R2-73-096, January, 1973. 99 p. 15 fig, 9 tab.

Descriptors: *Recycling, *Qualitative organic separation, *Gas condensation, *Farm wastes, Cattle, *Waste treatment, *Waste disposal, Fuels.
Identifiers: *Pyrolysis, *Feedlot waste, *Economic alaysis.

Beef cattle( steer) manure was obtained from a source that was free of soil contamination, and subsequently dried and pulverized. Replicate batch pyrolyses were carried out in stainless steel, glass, and iron tubes utilizing axial flow, at various levels of elevated temperature, and at atmospheric and lower pressures. Exhausts were carried by inert gas to traps and condensors. Qualitative separations and extractions were performed to determine the presence and quantity of various gases, ash, tar, and organics. Many constituents were extracted, but in such small quantities that their value may not pay for the cost of pyrolyzing. Larger scale pyrolyzing units should be tested to either confirm or disprove. (D. F. Anderson-Environmental Protection Agency, OR&M).

1623 - A1, B1, D1, E2 600

### DEWATERING BOVINE ANIMAL MANURE

Department of Agricultural Engineering, Pennsylvania State University, University Park.
H. D. Bartlett, R. E. Bos, and E. C. Wunz.
Presented at 1973 Annual Meeting of the American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-431, 26 p. 5 fig. 11 tab, 18 ref.

Descriptors: *Farm wastes, *Dewatering, *Cattle, *Waste treatment, *Waste disposal, *Waste storage, Slurries, Irrigation, Nutrients.
Identifiers: *Manure, Fibers,

Research was conducted to develop methods of dewatering bovine manure and determine the properties of the resulting fibrous and liquid components. Methods investigated were: stationary screens (hydrosieve), vibro-energy rotary screen (sweco), pressure filtration (d'Arcy equation), porous belt with press-rolls, perforated-shell cone centrifuge, and perforated-shell screw conveyor. Results of the dewatering methods are given and the fibrous and liquid components are analyzed. The liquid contained most of the nutrient value, with nearly half of the nutrients in the particle size range smaller than 325 U.S. Mesh. The chemical oxygen demand was approximately the same for the fibrous component and for the filtrate. Dewatering of manure would allow the liquid to be stored in earthern ponds for later use for crop irrigation. The fibrous solid could then be stockpiled without seepage, odor, or fly problems. (Frantz-East Central).

1624 - B1 600

### DRAINAGE SYSTEMS IN MILKING CENTERS

Food and Agricultural Engineering Department, Massachusetts University, Amherst.
R. G. Light.
Presented at 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-414, 11 p. 3 fig.

Descriptors: *Drainage systems, *Dairy industry, *Design, Farm wastes, Waste treatment, Slopes, Construction.
Identifiers: *Milking centers.

The design and construction of milking center floor drainage systems are often mishandled, resulting in continuing problems for the operator such as water ponding on floor surfaces, continuously wet floors, and excessive time in clean up after milking. These problems can be avoided by proper attention to required elevations at the site in advance of construction and by considering the following points: installation of piping of proper material, size and slope; properly trapped and vented drains; advance study of external manure and waste treatment requirements before construction; proper curbs, thresholds or elevation differences at door openings to control flow of floor wash water; slope rates of ¼-⅛ inch per foot for all floors subject to washing; and other structural designs which allow visual check of equipment malfunction, storage and reuse of milk room wash water, and lift stations for transferring wastes to treatment systems (if needed). (Lee-East Central).

1625 - B2, C5, D4 300

### TENTATIVE CRITERIA FOR DESIGN, CONSTRUCTION AND OPERATION OF THE BATCH TYPE PASVEER OXIDATION DITCH SYSTEM FOR THE TREATMENT OF ANIMAL WASTES

Department of Agricultural Engineering, Purdue University, Lafayette, Indiana.
A. C. Dale.
Unpublished Paper, February 15, 1968, 20 p. 30 fig, 2 tab, 20 ref.

Descriptors: *Design, *Construction, *Operations, *Oxidation lagoons, *Farm wastes, *Waste treatment, Aeration. Digestion, Aerobic bacteria, Anaerobic bacteria, Oxygen, Odor, Volatility, Biochemical oxygen demand, Nitrates, Nitrites, Temperature, Water pollution.
Identifiers: *Batch-type oxidation ditch, Facultative bacteria, Continuous treatment system.

A continuous oxidation ditch was developed by the Research Institute for Public Health Engineering, TNO, The Netherlands, as a low-cost method for purifying sewage emanating from small communities. The system is a modified form of activated sludge process and may be classified in the extended aeration group of odorless aerobic treatments. For either batch or continuous oxidation ditches to work satisfactorily, an aerator is used to "beat" oxygen into the waste to support the growth of bacteria and to hold the solids in suspension. Unlike the continous system, wastes are dumped into the batch oxidation ditch periodically and the aerator is not run continuously. The batch-type ditches reduce dry matter by about 40 to 50% by converting organic matter into carbon dioxide and water. The ditch releases some nitrogen but converts most of it into nitrites and nitrates. The pit (ditch) storage time may be increased by 80 to 90% provided effluent level can be controlled and oxygen transfer is possible at the greater suspended solids content. The oxidation ditch also concentrates the minerals and salt, by about 70 to 90% in the batch process. The design and operation of the oxidation ditch system is discussed in this report. (Cameron-East Central).

1626 - B1, D1, E1 400

### MANURE HANDLING SYSTEMS FOR THE FUTURE

Associate BEEF Editor.
B. Eftink, and L. Searle.
Successful Farming, Vol. 72, No. 1, p. 26-29, January, 1974. 11 fig.

Descriptors: *Farm wastes, *Waste treatment, *Waste disposal, *Recycling, Lagoons, Oxidation lagoons, Waste storage, Fish farming, Economics, Costs.
Identifiers: *Manure, *Future, Composting.

Most research efforts are incorporating the use of manure as an asset instead of a liability. The future promises that manure disposal will be designed to make it pay for itself and, in some cases, profitably. There are many methods for manure disposal, and this issue outlines some of them. They are: (1) Composting manure and selling it; (2) Recycling the liquids and treating manure; (3) Using treatment tanks to decompose manure; (4) Using a hog manure supplement; (5) Piping manure underground to a storage tank; (6) Screening out the solids; (7) Using an oxidation ditch; (8) Storing manure above ground; and (9) Growing fish in manure lagoons. Some of these nine methods of manure handling are now being used, while others are futuristic. Some will prove to be useful and economical, and some will be impractical. The positive approach of researchers and private entrepreneurs to manure disposal is both enterprising and reassuring. (Russell-East Central),

1627 - B2, D4 300

### ANAEROBIC-AEROBIC LAGOON TREATMENT OF DAIRY MANURE WASTES

Environmental Engineering Section, Engineering Research Division, Washington State University, Pullman.
D. E. Proctor.
Environmental Protection Agency Report No. EPA 660/2-74-030, May, 1974, 47 p. 10 fig, 7 tab, 6 ref.

Descriptors: *Aerobic treatment, *Anaerobic digestion, *Farm lagoons, *Dairy industry, *Farm wastes, Foam separation, Harvesting of algae. Waste treatment.
Identifiers: Dairy manure, Pacific Northwest, Washington State University, Anaerobic lagoons.

The removal of manure from dairy cattle confinement areas by improved hydraulic flushing techniques was attempted in conjunction with an attempt to treat the resulting manure slurry in an anaerobic lagoon and activated sludge process. Algae cells were allowed to propagate in the activated sludge process effluent in an attempt to then harvest the cells and accomplish nutrient removal as a final polishing step. While manure could be hydraulically moved by high velocity flushing jets, it resulted in a slurry that was too thick to flow by gravity to catch basins within the cattle confinement areas. The anaerobic lagoon-activated sludge process sequence did accomplish overall pollutional strength reductions as high as 90%. The activated sludge process effluent was still too high in organic strength, color, and nutrients to be discharged to surface waters, however. Dissolved air flotation of algae cells produced in shallow propagation ponds was ineffective. (Boydston-EPA, PNERL, NERC, Corvallis, Oregon).

1628 - A1, A5, B1, E2 300

### NEBRASKA ANIMAL WASTE RESEARCH

United States Department of Agriculture, Agricultural Research Service, Lincoln, Nebraska.
T. M. McCalla,
Proceedings, Workshop on Livestock Waste Management, Ft. Collins, Colorado, Great Plains Agricultural Council Publication 56, p. 18-28, 1972. 47 ref.

Descriptors: *Farm wastes, *Research and development, *Nebraska, *Feed lots, Runoff, Crop production, Costs, Management, Facilities, Odor, Terracing, Effluents, Water chemistry, Hydrology, Nitrates, Caissons, Waste disposal, Groundwater, Hydrology.
Identifiers: Loading rates.

Several different types of animal waste research are being studied. A discussion on each of the following is included in this paper: (1) land loading with manure, (2) costs for livestock waste management facilities, (3) feedlot runoff control and application of runoff on crops, (4) feedlot runoff control and feedlot waste management, (5) feedlot soil and water chemistry and groundwater hydrology, (6) runoff effluent disposal on cropland, and (7) odors. There is an explanation of each of these different studies; together with plans for continuing the research. (Cameron-East Central).

### 1629 - A6, B1 300
### CONTROL OF DUST FROM CATTLE FEEDLOTS

Texas Agricultural Extension Service, Texas A&M, College Station.
J. M. Sweeten.
Texas Agricultural Extension Service Report, Texas A&M University, College Station, April, 1974, 13 p. 2 fig. 1 tab, 12 ref.

Descriptors: *Control, *Dusts, *Cattle, *Feed lots, Rates of application, Sprinkling, Equipment, Air pollution, Sampling, Measurement, Stocking, Moisture, Costs.
Identifiers: Manure, Chemical application.
J. M. Sweeten.

Feedlot dust control methods including water application rates, equipment, treatment costs, and alternate strategies are described. The most important step in effective dust control is to attack the problem early and maintain steady control. The best means of feedlot dust control is water application. Either permanent sprinklers or mobile equipment can be designed, managed, and operated to provide effective feedlot dust control. Conclusions are that the cheapest and most effective means of dust control is application of water to the feedlot surface at a rate of 1 gallon per square yard per day (0.18 inches per day) initially, followed by daily water treatments of ½ gallon per square yard per day. Dust control practices should be initiated whenever the moisture content of loose surface manure falls below 20% (wet basis). (Cartmell-East Central).

### 1630 - B1, D4, E3 400
### MANURE AS A FUEL

Calf News, Vol. 12, No. 3, p. 48, 86-87, March, 1974. 2 fig.

Descriptors: *Fuels, *Farm wastes, *Waste treatment, *Waste disposal.
Identifiers: *Manure, *Composting, *Agricultural wastes.

If all agricultural wastes from plants and animals were available, they could be converted to energy equal to one-fifth of the petroleum or one-fourth of our natural gas requirements. A low-cost, high volume method of converting animal and plant wastes into a sulfur-free fuel through a new rapid composting process has been proposed as an immediate and practical way to face the current energy crisis. Feedlot manures alone would supply energy exceeding the total propane and other fuels would be freed to operate tractors and trucks or for other uses such as heating schools, homes and hospitals. Scientists have learned that organic wastes when composted produce a clean, sulfur-free fuel resembling lignite. This compost-fuel can also be produced at a lower cost than oil, propane, natural gas, coal, or other such fuels. The fuel is also stable and safe to handle or store. (Russell-East Central).

### 1631 - A5, A10, B2, C5, D4 300
### THEORETICAL CONSIDERATIONS OF ANAEROBIC LAGOONS FOR POULTRY WASTES

Agricultural Engineering Department, Iowa State University, Ames.
E. P. Taiganides.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, 13 p. 1 fig.

Descriptors: *Lagoons, *Poultry, *Farm wastes, *Waste treatment, *Waste disposal, *Anaerobic conditions, Odor, Design.
Identifiers: Flies.

Lagoons for the treatment and disposal of farm animal wastes are not the panacea they are reputed to be by the farm press. They have not been found suitable for the treatment of animal manures because of their high land surface and water requirements. The design criteria for the reduction of the solid matter of manure have not been established. Generally, lagoons will be judged by the following criteria: stabilization of the influent, control of odors, control of flies, and appearance. A properly functioning anaerobic lagoon should produce no vile odors. The main factors in anaerobic digestion are: temperature, loading rate, solids concentration, detention periods, volatile acid concentration, solid matter accumulation and scum formation, essential nutrients concentration, toxic substances, and pH. Some of the design criteria for anaerobic lagoons discussed are: size, water depth, inlet, outlet, shape, and location. The most advantageous time to start a lagoon is during the summer. Seeding procedures are discussed. Mixing aids the manure degradation process. Flies will not breed in an anaerobic lagoon unless a scum forms. Good bacteria husbandry dictates the continuous feeding of the lagoon, except when it is frozen. The value of anaerobic lagoons will be better defined after the end of experiments now in progress. (Solid Waste Information Retrieval System).

### 1632 - D1, E3, F1 400
### FEEDING STEERS DPM

Calf News, Vol. 11, No. 7, p. 26. July, 1973, 1 fig.

Descriptors: *Feeds, *Poultry, *Cattle, Proteins, Performance.
Identifiers: *Dehydrated poultry manure, Food and Drug Administration.

The poultry people have a product they are eager to bring into the cattle feeding market—dehydrated poultry manure. Properly processed poultry waste can be produced in large volumes for a cost to the producer of around $35 to $40 a ton. The holdup, up to now, has been the fact that the Food and Drug Administration has not given approval to use this product as a feed ingredient. On the other hand, there are several thousand cattle that are being fed poultry waste. As the law is now written, as long as one feeds the dried poultry waste in the State (other than transporting it across State lines), the Food and Drug Administration will cause you no problem. Because dehydrated poultry manure is inexpensive and has nutritional value, cattle owners may turn to this product as a cheaper source of supplement to their cattle rations. (Cartmell-East Central).

### 1633 - A2, B2, E2 400
### FAST FLUSH SYSTEMS

R. H. Brown.
Feedlot Management, Vol. 15, No. 11, p. 10-12, November, 1973. 4 fig.

Descriptors: *Farm wastes, *Cattle, *Waste treatment, *Waste disposal, *Feed lots, *Irrigation, Slopes, South Carolina.
Identifiers: Forage yields.

A southeastern U.S. Cattle farm uses fast flushing to remove wastes from concrete floors. Walworth Farms, feeding up to 5,000 head of cattle, flushes the 2½% sloping floor with up to 9,000 gallons of water. Runoff flows into a catch ditch to an underground pumping station which further liquifies it and then it flows into portable irrigation pipes. The runoff irrigates up to 1,600 acres of grassland and cropland. The farm also employs two lagoons to handle excess water when there are heavy rains. (Franz-East Central).

### 1634 - A2, B1 400
### HE SOLVED HIS MANURE HANDLING PROBLEM

T. J. Brevik.
Hoard's Dairyman, p. 357, March 10, 1973. 1 fig.

Descriptors: *Farm wastes, *Dairy industry, *Waste treatment, *Waste storage, *Feed lots, *Runoff, Water pollution, Design, Wisconsin.

A Wisconsin farmer developed a waste handling system that prevented barnyard runoff from running down a slope into a nearby stream. The plan included a 50x50x11 ft. concrete storage pit and curbs which diverted runoff from its natural course. A manure thrower was positioned at the end of the barn to sling wastes into the pit. A 40x60x7 ft. detention pond was recently added. Costs for the project were shared by ASCS. (Franz-East Central).

### 1635 - A5, B2, D4 100
### MINIMUM AERATION FOR CONTROL OF ODORS FROM SWINE WASTES

J. C. Converse, and D. L. Day.
Illinois Research, Vol. 14, No. 1, p. 12-13, 1972. 1 fig, 3 tab.

Descriptors: *Aeration, *Odor, *Hogs, *Farm wastes, *Waste treatment, Oxygen, Oxidation-reduction potential, Oxidation lagoons.
Identifiers: *Swine.

A study was conducted to determine whether odors could be kept at an acceptable minimum if a liquid swine manure system was operated so that no residual dissolved oxygen was present. A second objective was to determine how much the manure would be degraded under such conditions. The study was over a 22-week period. The system consisted of five chambers, each holding a constant volume of 15 liters. Contents of the chamber were mixed continuously so a representative portion of the liquor was removed daily. Chamber 1 was excessively aerated, but chamber 5 did not receive any air at all. Air was added continuously to chambers 2, 3, and 4 at rates to maintain the oxidition reduction potential (ORP) at -200, -300, and -400 millivolts, respectively. Data and figures are given as to the results from each of the 5 chambers. As a result of this test, it was found the ORP should be maintained in the range of -300 to -340 and pH in the range of 7.7 to 8.5. (Cameron-East Central).

### 1636 - D4, E3 400
### MANURE IS FOOD FOR PROTEIN

E. W. Manthey.
Feedlot Management, Vol. 16, No. 3, p. 18-22, March, 1974. 5 fig.

Descriptors: *Farm wastes, *Cattle, *Feeds, *Proteins, *Recycling, *Waste treatment, Nutrients, Fermentation, Thermophilic bacteria.
Identifiers: *Manure, *Refeeding, *General Electric.

A breakthrough in development of a process to convert cattle manure into feed so that it can be recycled in the feedlot was announced by General Electric. GE has opened a plant designed to convert cattle manure into a pasteurized protein powder by an aerobic fermentation process. This process feeds the manure to a strain of thermophilic bacteria that thrives on it under conditions set up in the plant. GE then harvests and dries the bacteria into a high protein feed supplement that can be fed to cattle. All of the manure is consumed in the process and even the water is used. The end product is bland, grayish powder that analyzes 55% protein. The system harvests 1½ pounds of protein per one pound of waste fed into the system. The product is actually the bacteria themselves, and the manure is only a source of energy. It is hoped that after experimental feeding proves the process a success, GE will begin marketing and producing the product on a large scale. (Russell-East Central).

### 1637 - E3 100
### HIGH FAT RATIONS FOR RUMINANTS. II. EFFECTS OF FAT ADDED TO CORN PLANT MATERIAL PRIOR TO ENSILING ON DIGESTIBILITY AND VOLUNTARY INTAKE OF THE SILAGE

Ohio Agricultural Research and Development Center, Wooster.
R. R. Johnson, and K. E. McClure.
Journal of Animal Science, Vol. 36, No. 2, p. 397-406, February, 1973. 8 tab, 20 ref.

Descriptors: *Feeds, *Silage, *Ruminants, Energy, Limestone, Farm wastes.
Identifiers: *Rations, *Fats, *Digestibility, Voluntary intake.

Saturated and unsaturated animal and vegetable fat were included with corn silage at levels of 4%, 8% and 12%. Beef steers and sheep were fed the silages on a voluntary consumption basis. A limestone addition alleviated an intake depression effect of unsaturated fat for cattle and sheep. The fat provided a larger contribution, 33%, of energy requirements, than had previously been successful. The organic acids in each of the 12 silages were analysed. Feces were analysed to determine the digestibility of each silage. The fat content of each silage is shown. (Frantz-East Central).

### 1638 - E2, F2 400

### EPA PREPARING TO "RAILROAD" THROUGH NEW POLLUTION RULES COVERING CATTLE FEEDLOTS

Beef, Vol. 9, No. 12, p. 4-5, August, 1973.

Descriptors: *Feed lots, *Cattle, *Farm wastes, *Effluent, *Water pollution, *Regulation, Livestock, Runoff.
Identifiers: *Environmental Protection Agency.

The U.S. Environmental Protection Agency, under a court order, is attempting to write regulating guidelines for effluent limitations on all industries. EPA has contracted Hamilton Standard to write the report. The proposed regulations do not allow any effluent discharge, regardless of weather conditions. Industry leaders are puzzled about the regulations and are hoping to have some influence on them when they go through the Federal Register. The regulations must be put into effect by October 18, 1973—the court-imposed deadline. (Frantz-East Central).

### 1639 - A2, A4, E2 100

### EFFECTS OF SURFACE IRRIGATION WITH DAIRY MANURE SLURRIES ON THE QUALITY OF GROUNDWATER AND SURFACE RUNOFF

Department of Agricultural Engineering, Tennessee University, Knoxville, ,
J. C. Barker and J. Sewell.
Transactions of the ASAE, Vol. 16, No. 4, p. 804-807, July-August, 1973. 1 fig. 4 tab, 9 ref.

Descriptors: *Irrigation, *Dairy industry, *Farm wastes, *Slurries, *Water quality, Ground water, Surface runoff, Bacteria, Nitrates.
Identifiers: *Manure.

The major objectives of this study were to determine the effects of slurry irrigation on surface runoff and groundwater quality and to develop techniques for irrigating with dairy manure slurry. One acre of concrete lot, loafing area, and building roofs at a dairy with about 125 milking cows was served by a slurry irrigation system where manure slurry, rainfall runoff, and wastewater were collected into drains and delivered by gravity flow into a 75,000-gallon concrete storage tank. The slurry was delivered through 4-in. portable aluminum irrigation pipeline to the field sprinkler. Grab samples of surface and groundwater were collected and analyses were made for bacteria, biochemical oxygen demand, dissolved solids content, nitrate nitrogen, orthophosphate, chloride, and residues. All median surface runoff nitrate nitrogen concentrations were within the permissable criteria for raw water for public supplies. All surface runoff chloride concentrations were well within the permissable criteria. The dissolved solids content of the manure-saturated surface runoff generally exceeded acceptable standards. The coliform bacteria concentrations for the surface runoff from both the manure-saturated and the conventional pasture exceeded the standard. (Cartmell-East Central).

### 1640 - B2, E2 300

### IRRIGATION FOR LAND APPLICATION OF ANIMAL WASTE

Department of Agricultural Engineering, Purdue University.
B. C. Horsfield, R. Z. Wheaton, J. C. Nye, and J. V. Mannering.
Bulletin, Agricultural Engineering Department, Purdue University, West Lafayette, Indiana. 20 p. 7 fig. 7 tab.

Descriptors: *Farm wastes, *Irrigation, *Waste disposal, Livestock, Crops, Soils, Runoff, Costs, Equipment, Indiana.
Identifiers: *Land application, *Animal wastes.

Irrigation may be the best means of putting farm wastes back onto the land. Runoff detention, combination manure-and-runoff, and covered manure facilities are described. Major soil and cropping factors affecting irrigation rate are evaluated. Irrigation equipment and systems' costs are described. Tips are given on waste storage management, irrigation equipment use, soil conditions, and crop utilization practices. Only with proper management can the farmer attain the desired results of irrigation. (Frantz-East Central).

### 1641 - B2, D4, E2 400

### TEST SWINE WASTE DISPOSAL SYSTEMS

Iowa State University.
T. Hargrove.
Wallace's Farmer, Vol. 96, p. 30, July 24, 1971. 3 fig.

Descriptors: *Hogs, *Waste disposal, *Farm wastes, *Testing, Water pollution, Air pollution, Lagoons, Sprinkler irrigation, Water hyacinth, Nutrients, Effluent.
Identifiers: *Swine, Gutters, Flushing.

Iowa State has installed a gutter system in a hog house with a 100-gallon flush lasting 30 seconds once an hour. The swine cooperate. Flushings may be routed to an anaerobic lagoon, an oxidation ditch, or the lagoon and ditch in turn. The excess is spread on corn and/or grassland. Flushing water is recirculated. Water hyacinths are being tested for removal of nutrients from effluents followed by use as cattle roughage. Iowa winters will keep them from becoming a nuisance. (Whetstone, Parker, Wells-Texas Tech University).

### 1642 - D1, E1 200

### EGG LAYING HOUSE WASTES

Vice President, Henry B. Steeg and Associates, Inc., Indianapolis, Indiana.
C. F. Niles, Jr.
Proceedings, Industrial Waste Conference, 22nd, Purdue University, May 2-4, 1967, Vol. 52, No. 3, p. 334-341. 1 fig. 2 tab.

Descriptors: *Farm wastes, *Waste storage, *Waste disposal, *Poultry, *Waste treatment, Drying, Anaerobic digestion, Incineration, Sedimentation, Centrifugation, Hydroponics, Sampling, Lagoons, Odor.
Identifiers: *Egg laying house, Land disposal.

Experiments were undertaken to find the best and most economical method of disposing wastes from the Berry Best Egg Company of Rockport, Indiana. The company houses approximately 205,000 laying hens. Manure, dead birds, and contaminated water were found to be the major types of wastes produced. Processes considered for use at the Berry Best Egg Company facilities included drying of the solids, controlled anaerobic digestion, land disposal, incineration, aerobic treatment, sedimentation, centrifuging, and hydroponic agriculture. Each process was investigated and experimented with to determine which would be the best method. During experimentation, wastes were pumped from holding tanks into two trucks and hauled to farmland for disposal. After extensive investigation, it was found that disposal of manure by drying and the disposal of the hen carcasses by mixing with manure was a satisfactory method of disposal. The waste water is then eliminated by irrigation. It is hoped that the material produced by drying will find a commercial market, but it is too early to determine whether or not it will. (Russell-East Central).

### 1643 - B1, C4 200

### MICROBIOLOGICAL ASPECTS OF POULTRY WASTES

Department of Veterinary Microbiology, Texas A&M University, College Station.
B. H. Lewis.
Proceedings: Second National Poultry Litter and Waste Management Seminar, College Station, Texas, Sept. 30 and Oct. 1, 1968, p. 77-81. 3 ref.

Descriptors: *Farm wastes, *Poultry, *Microbiology, Nutrients, Odor, Pahtogenic bacteria, Litter, Management, Texas.

Microbial mechanisms can assist in the efficient management and utilization of poultry waste. There is need for fundamental information on the general nature of the complex microbial species comprising poultry waste products and the substrate conversions which these bacteria bring about. The primary population of poultry waste consists of the fecal flora as it exists in the animal intestine. Recent studies on the intestinal flora of the domestic fowl reveal that organisms classified under the lactobacillius, lactic streptococcus, and bacteroid groups are the predominate types of organisms in feces. The nature of the secondary population of poultry waste is poorly understood since research is lacking. Specific activities upon environmental substrates which would make the utilization of poultry waste products feasible are divided into two categories: (1) those activities which would serve to synthesize nutrients for animal or plant use and (2) those activities which would reduce or eliminate undesirable factors as odors, pathogens, residues, etc. Those microbial activities of intestinal bacteria which contribute to the welfare of the host potentially could serve in the utilization of waste products, as evidence indicates that intestinal bacteria are capable of synthesizing several vitamins, and these vitamins are found in the feces. Further research into the microbiology of poultry waste must include techniques for the quantitative and qualitative evaluation of complex populations. (Solid Wastes Information Retrieval System).

### 1644 - B2, E1, F1 200

### TREATMENT OF ANIMAL WASTES AT THE GREENFIELD LABORATORIES OF ELI LILLY AND COMPANY

Eli Lilly and Company, Greenfield, Indiana.
T. W. Bloodgood.
21st Industrial Waste Conference Proceedings, Purdue University, Vol. 50, No. 2, p. 36-41, March, 1966. 1 tab, 1 ref.

Descriptors: *Waste treatment, *Farm wastes, Livestock, Waste disposal, Lagoons, Aeration, Effluent, Sewage.
Identifiers: *Animal wastes, *Greenfield Laboratories, *Eli Lilly and Company.

This paper describes the waste treatment facilities at the Greenfield Laboratories that handle the wastes generated by the thousands of animals used in the various production and research programs. There are five separate waste treatment plants that are located throughout the laboratories to serve the various research areas. Detailed description of wastes, treatment and disposal methods, and construction costs are given for each plant. The five plants are operated by two men from the Maintenance Department assigned to the Waste Treatment Operations. Total operating costs for all plants, not including utility costs, are approximately $25,000 a year. (Cartmell-East Central).

1645 - D1, E3 200

### ANIMAL WASTE MANAGEMENT AND NUTRIENT RECYCLING

Texas A&M University, College Station, Texas.
J. H. Quisenberry.
Latin American Poultry Congress, Mexico City, Mexico, March, 1972, 1972, 9 p. 7 tab, 1 ref.

Descriptors: *Farm wastes, *Management, *Nutrients, *Recycling, Poultry, Cattle, Fertilizers, Dehydration, Drying, Litter, Nitrogen, Phosphhorous, Potassium, Moisture, Analysis, Performance, Feeds.
Identifiers: Animal wastes, *Refeeding, Dropuings, Pasteurization.

Not only was poultry litter found to be of considerable economic value when recycled, but the return appears to be more than sufficient to bear the expense of drying when artificial drying is necessary. By this process the waste management problem may be reduced or solved, and if it is found desirable, the return may be sufficient to pay for pasteurization treatment and still leave some margin of net profit. Animal wastes to be recycled must be free of toxic or harmful residues. Ruminants were found to utilize poultry waste better than poultry because of the high concentration of nitrogenous compounds in poultry manure. Cattle feeding trials found that poultry manure contained adequate protein, low fiber content, adtequate calcium and phosphorous, but insufficient vitamin A and D. (Russell-East Central).

1646 - A1, D1, E1, F1 200

### SYSTEMS AND SITUATIONS FOR HANDLING POULTRY WASTES

Department of Poultry Science, Cornell Universcity, Ithaca, New York.
C. E. Ostrander.
Presented at the Southeastern Poultry and Egg Association 1971 Poultry Health Seminar, Oct. 18-19, 1971, 7 p.

Descriptors: *Poultry, *Farm wastes, *Waste storage, *Waste treatment, *Waste disposal, *Recycling, Oxidation lagoons, Lagoons, Dehydration, Hydraulic equipment, Fertilizers.
Identifiers: *Waste management, *Land spreading, Pollution, Refeeding.

The problems of waste management have become increasingly important to poultry men primarily because of increase in flock size, concentration of birds, and the population migration to the country. Problems of odor, noise, and proper waste disposal must be faced, and no one system is the answer. Many different systems are now being used each with its own advantages and disadvantages. Some poultrymen have deep pits to hold the waste until it can be spread on land. These pits must be kept reasonably dry and must be cleaned at least once a year. Another system is the hydraulic system in which the droppings are pushed out by water pressure into a storage facility. Waste then must be placed in an aerobic lagoon to prevent odors. Some men use oxidation ditches. Some attempt storage for long periods of time. As a general rule, waste must eventually be spread on land. Recently, dehydration and recycling as feed has gained attention. Price has been the discouraging factor in dehydration, and only about 10% of the waste can be recycled as feed, leaving the rest to be disposed of by some other method. Perhaps through more research the best method will some day be found. (Russell-East Central).

1647 - A8, B1 300

### HOUSE FLY CONTROL IN CAGED LAYER HOUSES

J. Aikman, and J. L. Lancaster, Jr.
Arkansas Farm Research, Vol. 21, No. 4, p. 4, July-August, 1972. 3 fig.

Descriptors: Larvae.
Identifiers: *Fly control, *Caged layers houses, *Manure, *Adulticides.

House fly control tests were conducted in three environmentally controlled houses for caged layers. The tests determined the effectiveness of manure removal coupled with applications of selective adulticides for house fly control. In the first house, manure was removed four times with water added. In the second house, manure was removed five times. But in the last house, a regular manure removal schedule was not maintaned. In each of the three houses bait was used to control adult flies. House fly counts were consistently higher in house #3. On the basis of this test, manure removal should begin early in the season and continue on a regular schedule for the entire fly season. This, along with applications of selective adulticides, will have good house fly control. (Cameron-East Central).

1648 - A5, B2 200

### ODOR INTENSITIES AT CATTLE FEEDLOTS

Texas Agricultural Extension Service, Texas A&M University, College Station.
J. M. Sweeten, D. L. Reddell, L. M. Schake, and B. Garner.
Presented at the 1st Annual Symposium on Air Pollution Control in the Southwest, Texas A&M University, College Station, Texas, November 5-7, 1973, 17 p. 3 fig, 7 tab, 20 ref.

Descriptors: *Odor, *Feed lots, *Cattle, Air pollution, Runoff, Farm wastes, Measurement, Weather data, Moisture, Settling basins.
Identifiers: *Scentometer, *Calcium Bentonite, Odor intensity index.

Odor intensities measured at two cattle feedlots in Texas, ranged from 2 to 170 dilutions to threshold (DT) which nearly covered the measurement range of the scentometer. The average odor reading for the surface of a 4000 head feedlot, determined by monitoring four randomly selected pens for 7 months, was 30.7 DT. The runoff settling basin and retention pond averages 68 and 47 DT, respectively. Half of the odor intensities were more than 23 DT (which exceeds the odor standards in several states). At a 12,000 head feedlot, trials using calcium bentonite as a ration supplement (at 0.0, 0.8, and 2.0% levels) showed a reduction in odors from the 2% bentonite treatment. Bentonite also improved average daily gain of cattle during the first 21 days. The scentometer was found to be a useful, if somewhat imprecise, diagnosis tool for identifying the primary sources of odors within a cattle feedlot. (Russell-EastC entral.)

1649 - B3, E1 200

### COMBINING MUNICIPAL WASTE WITH FEEDLOT WASTE

Texas Agricultural Extension Service, The Texas A&M University, College Station.
J. M. Sweeten.
Presented at the Fourth Annual Composting and Waste Recycling Conference, May 2-3, 1974, El Paso, Texas, 14 p. 3 tab, 18 ref.

Descriptors: *Municipal wastes, *Feed lots, *Farm wastes, *Waste treatment, *Waste disposal, Fertilizers, Odor, Nutrients, Moisture content, Costs, Economics, Sludge.
Identifiers: *Sanitaary landfill, *Land disposal, *Composting, Manure.

The characteristics and composting of both feedlot and municipal wastes are discussed in detail. Benefits of combining municipal solid wastes with feedlot waste appear to be on the side of muncipalities rather than the feedlot operator. At present day waste management costs, feedlot manure at $1.00-3.75 per ton is a bargain to farmers in terms of price and nutrient values as compared to municipal solid waste, which costs at least $7.75/ton composted and $2.00-3.80 per ton shredded only. In concentrated cattle feeding areas, sites suitable for sanitary landfills are usually plentiful, and municipalities will probably find sanitary landfilling a cheaper alternative than combining the refuse with animal waste for application on croplond. Raw or digested sewage is a more logical waste material to combine with municipal refuse since it is readily available, has similar properties to feedlot waste and presents a disposal problem of its own in nearly all cities. The concept of combining municipal refuse (composted or uncomposted) with feedlot manure does not appear feasible at this time, since municipal solid waste serves to dilute the nutrient value of manure. (Cartmell-East Central).

1650 - A5, B1 700

### CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL

J. D. Frus.
MS Thesis, Department of Agricultural Engineering, Iowa State University, 1969, 101 p. 21 fig, 21 tab, 40 ref.

Descriptors: *Chemical oxygen demand, *Odor, *Measurement, *Farm wastes, Gases, Sampling, Hogs, Confinement pens, Temperature, Humidity, Ventilation, Iowa.
Identifiers: *Swine.

The specific objectives of this project were to determine if the chemical oxygen demand technique could be used as a quantitative measure of the organic gases present in a confinement swine building atmosphere and to determine if the level of organic gases could be correlated with: observed odor level, period of time animals are in the building, air temperature, relative humidity, rate of dilution by ventilation, and characteristics of the waste. Samples were tested once a week but, in this project, drawing definite conclusions appeared to be almost impossible. A satisfactory technique was developed to measure the COD of the atmosphere in a confinement swine building. Determinations of what the air COD value included were not conclusive, but some suggested trends are: (1) The air COD values can be correlated with noticeable differences in odor level as detected by the human nose; (2) The air COD technique detected more different gases when the pH of the manure was above 7.0 than when it was below 7.0; (3) The air COD value rises sharply when the ventilation is turned off and drops sharply when it is turned on again; (4) The air COD values are the lowest when the pH of the manure in the pit is in the range of 6.8 to 7.2. (Cartmell-East Central).

1651 - A5, B2, D4 700

### MANURE TRANSPORT IN A PIGGERY USING THE AEROBICALLY STABILIZED DILUTE MANURE

R. J. Smith.
MS Thesis, Department of Agricultural Engineering, Iowa State University, Ames, Iowa, 1076, 99 p. 18 fig, 10 tab, 64 def.

Descriptors: *Aerobic treatment, *Anaerobic conditions, *Lagoons, *Farm wastes, *Hogs, Oxidation lagoons, Biochemical oxygen demand, Waste treatment, Cellulose, Equipment, Effluent, Sludge, Odor, Foaming, E. Coli, Analysis, Animal behavior.
Identifiers: *Manure transport, *Piggery, Housing.

Lack of satisfaction with the quality of effluent provided by an anaerobic lagoon as the sole biological treatment process for a confinement swine finishing house caused an investigation to be made of a combined anaerobic/aerobic treatment system. The performance of the total scheme has proven satisfactory. When using the system, no fresh water is required for manure transport. Continuous manure removal serves to keep odors at a low level in the building, and the systems treat and transport manure automatically. This reduces labor requirements for management of the operation. The effect of an anaerobic lagoon has proven to be beneficial in that its a good means of degrading cellulose. Also with a lagoon being used to remove a large fraction of the BOD from the waste before it enters the oxidation ditch, no serious foaming problems were encountered. (Russell-East Central).

## 1652 - A2, D2, D4, F1 700

### DESIGN AND OPERATION OF A FEEDLOT RUNOFF TREATMENT SYSTEM

D. S. Backer.
MS Thesis, University of Nebraska, Department of Civil Engineering, 1973, 46 p. 10 fig, 9 tab, 34 ref.

Descriptors: *Waste treatment, *Runoff, *Feed lots, *Design, Operation and maintenance, Equipment, Costs, Automation, Odor, Aeration, Chemical oxygen demand, Suspended solids, Effluent, Hydrogen ion concentration, Analysis.

This study dealt with the design, start up, and operation of a pilot plant built to treat feedlot runoff. The plant's purpose was to provide a system which was substantially automatic and economical in operation. The plant was evaluated for simplicity of construction, ease of operation and maintenance, cost of operation, effectiveness of treatment, and comparability to the laboratory unit. The design of the pilot plant was based on an aerobic unit that featured an air lift pump to return solids to the aeration chamber. Laboratory analyses were run on pH, chemical oxygen demand, and suspended solids. COD and suspended solids removals increased with increased detention time. The unit operated in the pH range 6.5-8.5. The net cost per animal was approximately $.60 for the experimental system. The field unit was easy to construct, required very little maintenance and was simple to operate. (Cartmell-East Central).

## 1653 - B2, C3, E2 100

### THE RESPONSE OF PASTURES IN NORTHERN ISLAND TO N, P, AND K FERTILIZERS AND TO ANIMAL SLURRIES. I. EFFECTS ON DRY-MATTER YIELD

Agricultural and Food Chemistry Department, Queen's University at Belfast, Northern Ireland.
S. N. Adams.
Journal of Agricultural Science, Vol. 81, pt. 3, p. 411-417, December, 1973. 1 fig, 6 tab, 14 ref.

Descriptors: *Fertilizers, *Slurries, *Farm wastes, Potassium, Nitrogen, Ammonium, Phosphorous, Nutrients, Soils, Waste disposal, Rates of application.
Identifiers: *Pasture response, *Northern Ireland, *Land spreading.

In Northern Ireland, experiments were conducted from 1969 to 1972 to measure effects on yield of 0, 180, or 360 kg of nitrogen 0, 30, or 60 kg of phosphorous; and 0, 150, or 300 kg of potassium/ha/year, both with and without 138,000 liters of slurry/ha. Results indicated that there was almost always a large increase in pasture yield when nitrogen was added. There were slight increases in yield when potassium was added and almost no effect either positively or negatively by phosphorous. In tests when slurry was added, the response of the yield to nitrogen was reduced and almost eliminated in phosphorus and potassium applications. The effect on yield was an increase because the ammonium-nitrogen in the slurry contributed the necessary nitrogen. Also when slurry was applied the nitrogen, potassium, and phosphorous concentrations were high and variable. This forces the conclusion that slurry application is a very inaccurate method of fertilizing. In fertilizing, the deficiencies of the farm as a whole should be evaluated to determine the proper amount of nutrients to add to the soil. (Russell-East Central).

## 1654 - B2, C3, E2 100

### THE RESPONSE OF PASTURES IN NORTHERN IRELAND TO N, P, AND FERTILIZERS AND TO ANIMAL SLURRIES. II. EFFECTS ON MINERAL COMPOSITION

Agricultural and Food Chemistry Department, Queen's University of Belfast, Northern Ireland.
S. N. Adams.
Journal of Agricultural Science, Vol. 81, pt. 3, p. 419-428, December, 1973. 3 fig, 6 tab, 11 ref.

Descriptors: *Fertilizers, *Slurries, *Farm wastes, Potassium, Phosphorous, Nitrogen, Nutrients, Calcium, Magnesium, Sodium, Rates of application.
Identifiers: *Pasture response, *Northern Ireland, Minerals, Herbage.

In Northern Ireland, pasture samples were taken and analyzed to determine the percent of nitrogen, phosphorus, potassium, calcium, magnesium, and sodium present. These analyses were conducted to find out the effect of nitrogen, phosphorus, and potassium fertilizers and slurry which had been added to the pasture. The data was then evaluated to see if a fertilizer policy designed for maximum yield should be modified after taking mineral content into account. It appears that the nitrogen amount to be added should be considered independently and with disregard to mineral content to achieve maximum yield. The amounts of phosphorus and potassium fertilizers added should be determined to avoid excess or depletion. Potassium and phosphorus fertilizer is much more effective than slurry amounts. In calculation of the proper amount of slurry to be added, one should also calculate the proper amount of potassium and phosphorous fertilizer which should be added to the slurry. On first cut, the slurries provided on an average: 115 kg $NH_4$-N/ha; 114 kg K/ha; 86 kg P/ha. (Russell-East Central).

## 1655 - B2, C3, E2 100

### THE RESPONSE OF PASTURES IN NORTHERN ISLAND TO N, P AND K FERTILIZERS AND TO ANIMAL SLURRIES. III. EFFECTS IN EXPERIMENTS CONTINUED FOR EITHER TWO OR THREE YEARS

Agricultural and Food Chemistry Department, Queen's University at Belfast, Northern Ireland.
S. N. Adams.
Journal of Agricultural Science, Vol. 82, pt. 3, p. 129-137, February, 1974. 3 fig, 4 tab, 17 ref.

Descriptors: *Fertilizers, *Slurries, *Farm wastes, Nitrogen, Phosphorus, Potassium, Ammonium, Rates of application.
Identifiers: *Pasture response, *Northern Ireland, Herbage.

Experiments were conducted in Northern Ireland on pastures to determine the effect on yield and mineral content of 0, 180, and 360 kg Nitrogen, 0, 30, or 60 kg phosphorus, and 0, 150, or 300 kg potassium/ha/year both with and without 138,000 liters slurry/ha. These were conducted in 1970 and 1971 on the same sites and with the same applications as previous experiments in 1969. The nitrogen content in the soil in the second and third seasons was similar to the first season with good yields and no nitrogen buildup, Evidence showed that the soil reserves of phosphorus were not being depleted, and the slurry phosphorus seemed to be adequate to maintain the proper level. The potassium in the soil on the other hand was getting smaller with accompanied reductions in yield. Adding fertilizer potassium prevented this reduction, but the potassium in the slurries was less effective. This is probably because the potassium in the slurries is organically bound, (Russell-East Central).

## 1656 - A2, B1 700

### MATHEMATICAL MODELING AND SYSTEM ANALYSIS OF CATTLE FEEDLOT RUNOFF MANURE WASTES

S. Kang.
MS Thesis, Department of Chemical Engineering, Kansas State University, 1969, 150 p. 36 fig, 14 tab, 29 ref.

Descriptors: *Mathematical models, *Systems analysis, *Feed lots, *Runoff, Cattle, Water pollution, Dimensional analysis, Simulation analysis, Rainfall.
Identifiers: Analog computer, Quasilinearization.

The control of water pollution by feedlot runoff can not be accomplished effectively without an appropriate understanding of the system. In this study, the emphasis was on obtaining a mathematical relation which relates the important dependent variables of the system to the important independent input variables. A simplified nonlinear model of the systems is first proposed.. An analog computer is used to solve the nonlinear equations. Correlation of the system parameter to the rainfall intensity is discussed. Analog computer simulation was found to be satisfactory in the study of transient behavior of the system. Based on the proposed model, the injection rate of the organic matter into the runoff solution is found to be very approximately linear with respect to the rainfall intensity. This injection rate is somewhat independent of the surface condition of the feedlot system. For a complex physical system, the response of the system under varied input variables may be the most informative knowledge to justify a proposed modeling. It is suggested that additional hydraulic and concentration data be taken systematically and in a shorter time interval. (Cartmell-East Central),

## 1657 - B2, D3, D4, E2 100

### MINERALIZATION OF NITROGEN IN MANURES MADE FROM SPENT-SLURRY

Division of Soil Science and Agricultural Chemistry, I.A.R.I., New Delhi, India.
R. D. Laura, and M. A. Idnani.
Soil Biological Biochemistry, Vol. 4, p. 239-243, 1972. 3 tab, 18 ref.

Descriptors: *Nitrogen, *Fertilizers, *Slurries, Urea, Dehydration, Absorption.
Identifiers: *Mineralization, *Manure, *Spent-slurry, Composting.

The problem of using liquid spent-slurry or sludge was studied from three aspects: (1) the dehydration of slurry by absorption in materials like green leaf powder; (2) the use of slurry to initiate composting of other waste materials; and (3) the production of concentrated organo-mineral fertilizer by adding urea to the dried slurry. Manure prepared by absorption in green leaf powder proved to mineralize rapidly, which would indicate that this is a valuable means of utilizing slurry, Sun drying reduced mineralization considerably more than absorption. Liquid slurry was also found to be superior to farm compost. Mineralization was increased with alternate wetting and drying and with 1% sodium hydroxide added to the dry slurry. The organo-mineral fertilizer prepared by adding urea yielded over 50% nitrogen which was 30% less than from urea alone. (Russell-East Central).

## 1658 - A2, B1 300

### CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM AGRICULTURAL LANDS

Department of Agricultural Economics, Cornell University, Ithaca, New York.
J. J. Jacobs.
Cornell Agricultural Economics Staff, Paper No. 72-20, June, 1972, 16 p. 2 fig, 4 tab, 20 ref.

Descriptors: *Sediment control, *Nutrients, *Agriculture, *Phosphorus, Farm wastes, Livestock,

Water pollution, Runoff, Model studies, Costs. Sources of potential pollutants from agricultural production are: sediment from erosion; plant nutrients; livestock manure; pesticides; waste from processing plants; air pollution, primarily odors and dusts. Sediment and phosphorus were cause of the magnitude of sediment as a pollutant, the increased emphasis on phosphorus as a likely key nutrient in limiting growth of aquatic plant life, and the diffuse source of such pollutants from agricultural runoff as compared to point sources. Surface runoff from agricultural cropland is the primary transport agent of sediment entering surface waters. Therefore, planning for the control of sediment requires knowledge of the relations between those factors that cause loss of soil and those that help reduce such losses on cropland. The methods allowed for controlling sediment and phosphorus losses are presented. The question of which control methods and at what level depends on the level of water quality desired, the unit cost coefficients of alternative methods, and the technical coefficients of the alternative methods. A summary of the cost coefficients are presented. Sediment and phosphorus coefficients were also estimated for each management system listed. (Cartmell-East Central).

### 1659 - B1, E2 100

### ULTIMATE DISPOSAL OF WASTES TO SOIL

Battelle Memorial Institute, Pacific Northwest Laboratory, Richland, Washington.
R. C. Rouston, and R. E. Wildung.
Chemical Engineering Progress Symposium Series, Vol. 65, No. 97, p. 19-25, 1969. 49 ref.

Descriptors: *Wastes, *Farm wastes, Ultimate disposal, Recycling, Waste storage, Dispersion, Nitrogen, Phosphorus, Sulfur, Ammonia, Ion exchange, Filtration.
Identifiers: Soil, Dilution, Soil interconversions, Buffers, Organic materials, Transformations.

Soil is a complex medium which is capable of reacting with a broad spectrum of extraneous materials. The nature of these reactions is such that soil may function as a medium for either waste storage or for ultimate waste disposal. Soil is composed of inorganic minerals, organic materials, and a living population of organisms. A soil system is a highly reactive system which may bind or alter the composition of waste solutions added to it. Soil properties important to the efficient use of the soil as a disposal medium include ion exchange capacities, buffer capacity, filter characteristics, and microbial transformations. The ultimate disposal alternatives available with respect to soil systems are the reuse and transformation of waste. In the reuse category are those solute disposants which are major essential elements to plants. In the transformation category are the inorganic or biological components which can be transformed to be useful for plant growth. The elements nitrogen, phosphorus, and sulfur would be most amenable to biological interconversions. (Russell-East Central).

### 1660 - A4, B2, E2 100

### FLUCTUATIONS IN NITRATE CONCENTRATIONS UTILIZED AS AN ASSESSMENT OF AGRICULTURAL CONTAMINATION TO AN AQUIFER OF A SEMIARID CLIMACTIC REGION

Eastern New Mexico University, Portales.
R. G. Taylor, and P. D. Bigbee.
Water Research, Vol. 7, No. 8, p. 1155-1161, August, 1973. 1 fig, 4 tab, 9 ref.

Descriptors: *Nitrates, *Fluctuations, *Water pollution, *Aquifers, Semiarid climates, *New Mexico, Investigations, Agriculture, Sampling.
Identifiers: Health, Concentration, Agricultural practices.

This study was conducted to observe fluctuations in nitrate concentrations in an agricultural area near the eastern border of New Mexico. Nitrate concentrations have been utilized in this study to demonstrate their applicability to examining agriculture practices which contaminate aquifier water. Areas treated with nitrogenous fertilizers and subsequently irrigated were found to contain aquifier fluctuations in nitrate content directly in proportion to irrigation seasons. Agricultural industries with high animal densities per land area, and high water consumption for maintenance, were found to have high, but non-fluctuating, nitrate concentrations, Areas with high animal density per land area with low water usage for maintenance; areas with low animal density per land area; and agricultural practices for which little or no nitrogenous fertilizers were used demonstrated low aquifier nitrate concentrations regardless of water usage. It was concluded that fluctuations in nitrate concentrations in an aquifier can be utilized in assessing the contamination resulting from agricultural practices in semiarid climates. (Solid Waste Information Retrieval System).

### 1661 - A5, B2, D4, F1 100

### OXIDATION WHEEL ELIMINATES ODORS, MANURE HANDLING AND POLLUTION

Compost Science, Vol. 13, No. 1, p. 28, January-February, 1972.

Descriptors: *Oxidation, Farm wastes, *Odor, *Hogs, *Aeration, Poultry, Slurries, Costs, Waste treatment.
Identifiers: *Oxidation wheel, *Manure.

Paul Smart is using an oxidation wheel that is economically feasible and virtually maintenance free. The key to Smart's success is his new wheel design. He is using 26 of the massive units—which measure 36" wide by 60" in diameter. The big diameter on the new wheel lets the bearings sit up on the walls of the pit away from the slurry. The wheels whip oxygen into the manure slurry as it flows around in a race-track-shaped pit. The aeration encourages growth of aerobic bacteria, which break down manure without forming the usual foul-smelling gases. University of Kansas tests show the new design puts 4 lbs. of oxygen per hour per wheel into the pit. The result is a thick reddish sludge that oozes from each house to an evaporation pond. Costs for operation of the wheels is 89c per hog marketed. One wheel costs about $37 a month to run. Smart is confident the wheel will work well for poultry, but admits to reservations for cattle. (Cameron-East Central).

### 1662 - B1 400

### THESE STOCKYARDS' SOLUTIONS COULD WORK FOR YOU

Feedlot Management, Vol. 15, No. 5, p. 48-52, May, 1973. 3 fig.

Descriptors: *Livestock, *Farm wastes, *Feed lots, *Management, Waste treatment, Waste disposal, Lagoons, Incineration.
Identifiers: *Stockyards.

A tour of several markets turned up a number of methods for successfully handling livestock wastes. These techniques might be adaptable to feedlot operations. Features that will make waste removal faster and more efficient include a flow-through alley system, new concrete floors to replace brick floors, and steel pens instead of the present wooden ones. Most large markets are successfully meeting the challenge of controlling pollution. Major remodeling programs, and such new concepts as lagoon systems, disposal districts, and incinerators require large financial expenditures. (Cartmell-East Central).

### 1663 - A4, B1 100

### INFLUENCE OF AGRICULTURAL PRACTICES ON WATER QUALITY IN NEBRASKA: A SURVEY OF STREAMS, GROUNDWATER, AND PRECIPITATION

Department of Agronomy, Nebraska University, Lincoln.
R. A. Olson, E. C. Seim, and J. Muir.
Water Resources Bulletin, Vol. 9, No. 2, p. 301-311, April, 1973, 3 fig, 2 tab, 11 ref.

Descriptors: *Water quality, *Nebraska, *Surveys, *Water pollution, Nitrogen, Phosphorus, Fertilizers, Farm wastes, Industrial wastes, Sewage.
Identifiers: Agricultural practices.

The objective of this investigation was to determine if agricultural practices in Nebraska are contributing to pollution of the state's water resources. A water-sampling program was initiated throughout Nebraska in 1970 for the purpose of establishing the sources of nutrients enriching Nebraska's waters. Particular emphasis was placed on measuring the forms and amounts of nitrogen and phosphorus—two of the primary nutrients contained in fertilizers. Significant quantities of N and P were found in the precipitation of Nebraska, ranging from 5-7 pounds N/A in the west to 10-14 pounds in the east and ½-1 pounds P/A in the same directions. Elevated nutrient levels of Nebraska's streams were more often than not traceable to industrial, livestock, and sewage waste intrusions. Phosphorus content has remained essentially constant, but there is evidence of a small increase in the average $NO_3$-N content, of Nebraska groundwater during the past 10 years, a period during which fertilizer N use has quadrupled. Some individual cases of misuse of fertilizers are recognized, but the weight of evidence from this investigation indicates that fertilizers aren't contributing significantly to the degradation of surface and groundwater quality in Nebraska to date. (Cartmell-East Central).

### 1664 - A2, C1 100

### A PROGRAMMED SAMPLER FOR RUNOFF AND BEDLOADS

Agricultural Research Service, Lincoln, Nebraska.
N. P. Swanson.
Transactions of the ASAE, Vol. 16, No. 4, p. 790-792, July-August, 1973. 5 fig, 5 ref.

Descriptors: *Feed lots, *Runoff, *Bed load, *Nebraska, *Sampling, *Pollutant identification, Chemical analysis, Rain gauge, Hydrograph analysis, Farm wastes.
Identifiers: Feedlot research, Quantitative analysis.

A programmed, automatic sampler that collects a sequence of composite samples of runoff and accompanying bedloads has been in use on a feedlot research installation near Lincoln, Nebraska, for over four years. The sampler consists of an arm and dipper electrically driven by a gear reduction motor through sprockets and a chain, a tipping bucket that collects the samplings from several rotations of the dipper and delivers them as a single sample, a turntable holding successive sample containers, a gear reduction motor moving the turntable by a friction drive, and a program timer. Composited samples are collected over five minute sampling periods with volumes of about three liters. The sampler can be programmed to obtain individual samples for any of the 144 five minute periods during 12 total hours of actual operation. The runoff need not be continuous. The time of collection of each sample is recorded to relate to the runoff hydrograph and recording rain gauge chart. Bedload particles up to 5/8 inch in diameter can enter the rotating sampler dipper which passes under the discharge. The sampler permits both qualitative and quantitative analyses of runoff with relation to time for an event. Maintenance and field servicing requirements have been minimal (Merritt-FIRL).

### 1665 - A9, B2, C5, D4 700

### MICROBIAL ECOLOGY AND INFECTIOUS DRUG RESISTANCE IN A FARM WASTE LAGOON

Young Nam Lee.
MS Thesis, Department of Bacteriology, North Dakota State University, June, 1971, 56 p. 10 fig, 7 tab, 72 ref.

Descriptors: *Farm wastes, *Lagoons, *Ecology, *Bacteria, *Microbiology, Feeds, Antibiotics, Sampling, Biochemical oxygen demand, Hydrogen ion concentration, Algae.
Identifiers: *Drug resistance.

Two phases of research constituted this study. The first phase was to study the monthly physical, biochemical, and microbiological variation in a barn waste lagoon located near North Dakota State University, Fargo. This lagoon drains into the Red River and any antibiotic resistant organism present could come in contact with sensitive human pathogens in a public water supply. The second phase concerned assays of the antibiotic sensitivity spectra of lagoon isolates originating from the intestinal tract of animals on feed supplemented with antimicrobial agents. Data indicated that this lagoon may constitute a potential health hazard due to a low, but consistent, population of antibiotic-resistant enteric pathogens which may gain access to public waters. More than three hundred and fifty gram negative bacteria were isolated and screened for determination of the resistance to antimicrobial agents commonly used as growth promoting feed additives. Conjugation experiments were also conducted to demonstrate the transferability of R factors carrying multiple antibiotic resistance. The release of organisms carrying R factors from farm animals on conventional feeds may play a role in the spread of multiple drug-resistant strains. (Russell-East Central).

### 1666 - B2, D2, D4 700

### PERFORMANCE OF A CAGE ROTOR IN AN OXIDATION DITCH

R. S. Knight.
MS Thesis, Department of Agricultural Engineering, Iowa State University, 1965, 83 p. 25 fig, 5 tab, 30 ref.

Descriptors: *Oxidation lagoons, *Performance, *Farm wastes, Aeration, Equipment, Velocity, Waste water treatment, Activated sludge, Flocculation, Waste treatment.
Identifiers: *Oxidation ditch, *Cage rotor.

The cage rotor aerator tested in this study is a very efficient method of mechanical aeration and should have definite applications in waste water treatment. The rotor was capable of transferring up to 5.65 lbs. of oxygen per foot of rotor at 12 inches immersion at 100 rpm and should be capable of greater transfers at higher speeds. The most efficient immersion depth of the rotor was 3 inches, and it was capable of efficiencies of 5.28 to 6.76 pounds of oxygen per kilowatt hour at this immersion. There also appears to be a relationship between the velocity of the water in the ditch and the oxygen transferred at any constant output of the rotor. If the power output is held constant, the oxygen transferred tends to increase as the velocity decreases. However, all velocities at all rotor speeds and immersions appear to be sufficient to keep an activated sludge floc in suspension. One other finding was that the oxygen transfer possibilities are effected by the volume or shape of the aeration tank. In other words, the results of rotor performance studies in one type of aeration tank should not be accepted as accurate transfer values for the same rotor in a tank of different size and shape. (Russell-East Central).

### 1667 - B2, D2, D4 100

### THERMOPHILIC BACTERIAL OXIDATION OF HIGHLY CONCENTRATED SUBSTRATES

Stuttgart University, Institute of Siedlungswasserbau, 7 Stuttgart 1, Maliwek 9, Federal Republic of Germany.
F. Popel and CH. Ohnmacht.
Water Research, Vol. 6, p. 807-815, 1972. 6 fig, 3 tab, 9 ref.

Descriptors: *Thermophilic bacteria, *Farm wastes, Industrial wastes, Oxidation, Aerobic bacteria.
Identifiers: Mesophilic bacteria, Pasteurization, Substrates.

Disposal of substrates with high amounts of pathogenic bacteria and oxidizable organic matter can be accomplished without polluting resources after proper stabilization, pasteurization, and deodorization. This is accomplished by heating them long enough to degrade the pathogenic bacteria and organic matter. The heat is provided by exothermic reactions in aeration tanks to which the sludge has been added. The sludge must be continually recirculated to aid mesophilic and/or thermophilic bacteria and to provide an oxygen balance in the circulating liquid. Exothermic reactions heat the substrates up to 65-70 degrees centigrade which accelerates the rate of degradation of the organic matter and pasteurization of the substrates. Also large quantities of humus compounds are produced during the oxidation. This process can be used on highly concentrated substrates with a high $BOD_5$ such as sewage sludge, liquid manure from animals, or industrial waste. (Russell-East Central).

### 1668 - B1, C3, C5, D1 700

### NITROGEN TRANSFORMATION DURING AEROBIC DIGESTION OF DAIRY CATTLE MANURE

A. C. Chang.
PhD Thesis, Department of Agricultural Engineering, Purdue University, Lafayette, Indiana, January, 1971, 116 p. 30 fig, 46 tab, 48 ref.

Descriptors: *Nitrogen, *Aerobic digestion, *Cattle, *Dairy industry, *Farm wastes, *Waste treatment, Water pollution, Denitrification, Chemical oxygen demand, Ammonia, Nitrates, Nitrites, Sampling.
Identifiers: *Manure, Land disposal.

Because of the high content of nitrogen in livestock waste and because of the possibilities of pollution by nitrogen, this study was undertaken. The fate of nitrogen during aerobic digestion of dairy cattle wastes was investigated. Also, the study was designed to seek a possible way of removing nitrogen before final disposal. Results indicated that dairy cattle wastes can be stabilized by aerobic digestion. Analyses also showed that temperature has a significant effect on the total nitrogen and stability of the digested wastes at the 5% level. It was concluded that nitrogen loss during aerobic digestion was due to volatilization of ammonia and the nitrification-denitrification sequence. After digestion was complete, the inorganic nitrogen in the heavily treated cattle waste can be removed by denitrification. However, this denitrification must be aided by a sufficient supply of organic substrate and some acclimated sludge. The overall efficiency of total nitrogen removal on a daily feed is 78.0% with the use of glucose as organic substrate and is 56.22% with the use of a dairy cattle manure slurry as organic substrate. (Russell-East Central).

### 1669 - D3 100

### TOXICITY TO FLY LARVAE OF THE FECES OF INSECTICIDE-FED CATTLE

Entomology Research Division, Agricultural Research Service, United States Department of Agriculture, Corvallis, Oregon.
G. W. Eddy and A. R. Roth.
Journal of Economic Entomology, Vol. 54, No. 3, p. 408-411, June, 1961. 3 tab, 7 ref.

Descriptors: *Toxicity, *Larvae, *Farm wastes, *Cattle, *Insecticide.
Identifiers: *Flies, *Feces, *Insecticide-fed cattle.

Twenty-five insecticides were tested for their effectiveness against the larvae of feces-breeding flies. The cattle were given a ration of feed and insecticides for five days. Bayer 22408 and Co-Ral, proving lethal at 1.0 mg. per kg. of animal weight, were most effective compounds were also added to fresh manure to determine minimum lethal concentrations. Larval toxicity was determined at lethal and sublethal levels of dosage. There was a wide range of effectiveness for the insecticides tested. (Frantz-East Central).

### 1670 - D3 100

### TOXICITY TO FACE FLY AND HOUSE FLY LARVAE OF FECES FROM INSECTICIDE-FED CATTLE

Agricultural Research Service, United States Department of Agriculture.
Journal of Economic Entomology, Vol, 54, No. 3, p. 406-408, June, 1961. 5 fig, 1 tab.

Descriptors: *Toxicity, *Larvae, *Farm wastes, *Cattle, *Insecticides.
Identifiers: *Flies, *Feces, *Insecticide-fed cattle.

An experiment was conducted to determine larval development of face flies (*Musco autumnalis* DeGree) and house flies (*Musca domestica* L.) in the feces of cattle fed a grain and insecticide ration. Co-Ral and Bayer 22408 were administered for 5 days at rates of .5 and 1.0 mg per kg. of cattle weight. Ronnel was administered at rates of 2.5 and 5.0 mg/kg. The feces was infested with both face fly and house fly larvae. Both Co-Ral and Bayer 22408 inhibited larval development at both dosage levels. Ronnel was effective against both species' larvae at the higher level and effective against face flies at the lower level. (Frantz-East Central).

### 1671 - A2, B1 600

### PERFORMANCE OF FEEDLOT RUNOFF CONTROL FACILITIES IN KANSAS

Agricultural Engineering Department
Kansas State University
Manhattan
J. K. Koelliker, H. L. Manges, R. I. Lipper.
Presented at 1974 Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4012, 17 p. 2 fig, 3 tab., 9 ref.

Descriptors: *Feed lots, *Runoff, *Control, *Kansas, *Models, Performance, Design, Disposal, Irrigation.
Identifiers: *Watershed.

A continuous watershed model utilizing daily inputs has been developed to evaluate expected performance for feedlot runoff control facilities for Kansas conditions. In Kansas, runoff control structures sized to contain the entire volume of the 10-year and 25-year 24-hour precipitation from the feedlot and dispose of 10 percent of the design volume per disposal day would control from 9.13 to 99.4 and 43.0 to 100.00 percent, respectively, of all runoff from an unsurfaced feedlot from east to west across the state. About one-third of the average precipitation in Kansas is expected to run off of an unsurfaced feedlot while about forty-four percent is expected to run off of a surface lot. Based upon results of this watershed model, evaporation pond sizes to provide as good or better control for Kansas than land disposal systems would be 6 feet deep for a surface area 120 percent of the minimum surface area and 4 feet deep for a surface area 150 percent of the minimum surface area. Use of this watershed model allows prior evaluation of various alternative systems for both the level of pollution control expected as well as management feasibility. (Cartmell-East Central).

### 1672 - A1, E2 300

### EFFECT OF APPLYING SWINE FECES ON SOIL AND PLANT MINERAL LEVELS

J. D. Hedges; E. T. Kornegay, and D. C. Martens.
Livestock Research Report, Research Division Report 153, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, July, 1973, p. 1-7, 4 tab,

Descriptors: Hogs, *Farm wastes, *Waste disposal, *Soils, *Copper, Sampling, Rates of application, Potassium, Phosphorus, Zinc, Calcium, Hydrogen ion concentration.
Identifiers: *Swine, *Manure, *Plant mineral levels, Land spreading.

Manure collected from finishing hogs fed rations with and without copper was spread on silt loam soil to determine the effect on the growth and mineral composition of corn and on the movement of these minerals in the soil. Manure was applied at the rate of 6.9 tons per acre between rows when corn was four inches tall. The copper content of the control feces was 88 ppm as compared to 1460 ppm for the high copper feces. Results from the high copper feces area indicated that the copper increased substantially in the soil but only slightly in the corn ear leaf. During the one growing season copper did not appear to move down in the soil. Phosphorus, calcium, and magnesium content of the soil increased with no change in the amount of magnesium and calcium in the plants. There were no changes in the levels of potassium, zinc, and iron in the soil or plants. Phosphorus appeared to move down while magnesium and calcium remained in the surface of the soil. (Russell-East Central)

### 1673 - B1 100

### TROUT METABOLISM CHARACTERISTICS AND THE RATIONAL DESIGN OF NITRIFICATION FACILITIES FOR WATER REUSE IN HATCHERIES

Department of Civil Engineering
Texas University
Austin
R. E. Speece
Transactions of the American Fisheries Society, Vol. 102, No. 2, p. 323-334, April, 1973. 14 fig. 12 ref.

Descriptors: *Trout, *Metabolism, *Data collections, *Design, Nitrification, *Facilities, *Water reuse, *Fish hatcheries, Oxygen requirements, Ammonia, Suspended solids, Temperature, Feeding rates, Biochemical oxygen demand.
Identifiers: Nomograph.

This paper is an attempt to bring together the available information on trout metabolism and nitrification with the objective of establishing a rational procedure for the design of nitrification facilities for water reuse in trout hatcheries. The same rationale as used in this paper can be used for other types of fish through the use of the appropriate ammonia production, oxygen requirement, and water requirement data. Data have been taken from the literature on trout culture to mathematically define the ammonia production, oxygen requirements, BOD and SS production, water requirements, and loading rates as a function of trout length and water temperature. The temperature dependence of feeding rate and nitrification capacity has been incorporated into a nomograph which predicts the nitrification volume requirements for recycling. Another nomograph was constructed to predict water flow requirements and pollution resulting from trout hatchery operation. (Cartmell-East Central).

### 1674 - A5, B2, D2, D4 400

### NOW, NO ODOR WASTE HANDLING

Swine editor.
R. J. Fee.
Successful Farming, Vol. 71, No. 9, p. K14, August, 1973. 2 fig.

Descriptors: *Odor, *Waste treatment, *Hogs, *Farm wastes, Centrifugal pumps, Sewage, Costs, Effluents, Iowa.
Identifiers: Pits.

A new concept in odorless waste handling for hogs is being used on the Orville Luedtke farm in Iowa. The basic principal of the Rem-Ox system is that it uses atmospheric oxygen to maintain and aerobic condition in the waste for fast, odor free organic material digestion. All waste treatment is done within the building, using centrifugal force, circulating sewage pumps to agitate and aerate the material in the pits. Unlike other confinement operations, the "racetrack design" pits in the Luedtke's system can be much more shallow than usual. The centrifugal force sewage pumps are placed at strategic locations to propel the effluent in a circular fashion around the building. Cost depends on the size and type of structure. Sizing of pumps and motors is based primarily on the daily animal manure input into the system. (Cameron-East Central).

### 1675 - B2, C3, D4 100

### NUTRITIVE VALUE OF AEROBICALLY SUSTAINED SWINE EXCREMENT

Illinois University
Urbana-Champaign
B. G. Harmon
Journal of Animal Science, Vol. 34, No. 3, p. 403-407, 1972. 1 fig, 7 tab, 12 ref.

Descriptors: *Nutrients, *Swine, *Farm wastes, Aerobic conditions, Oxidation lagoons, Proteins.
Identifiers: *Excrement.

The aim of this study was to measure the nutritive value of solid residue collected from aerobically-maintained swine excrement present in an oxidation ditch. Four studies were conducted with the solid precipitate of aerobically sustained swine waste. Settled solids (ODR) collected from an oxidation ditch and containing 27.7% protein were substituted for other protein sources in studies with weanling rats. The protein of ODR could replace one-third to one-half of the protein of casein or soybean meal and support similar weight gains although gain/feed ratio decreased as ODR was increased in the diet. Feed intake was not reduced by the addition of ODR in any of the studies. The protein and energy digestibility values for ODR was less than those for the casein containing basal diet. The addition of lysine or tryptophan individually to a corn-ODR diet did not influence gain while the combination significantly increased gain and gain/feed suggesting that these amino acids were most limiting and nearly equally limiting in that diet. (Cartmell-East Central).

### 1676 - B3, C5, D2, D4, E2, E3 400

### ORGANIC FERTILIZER OFFSHOOT OF POLLUTION-FREE FEEDLOT

Anonymous
Feedlot Management, Vol. 15, No. 13, p. 9-12, December, 1973, 4 fig.

Descriptors: *Fertilizers, *Pollution, *Feed lots, *Cattle, *Farm wastes.
Identifiers: *Organic fertilizer, *Digester, Disease control.

The Ohio Feed Lot Inc. is developing the first animal waste, large scale sterilized organic fertilizer. By means of a digester, a machine capable of circulating air through the accumulated manure, Ohio Feed Lot is speeding up nature's aerobic process. The digester, housed in a 700 by 120 ft. pre-coated galvanized steel building, is fed 400 tons of manure daily. The manure is collected by front-loading tractors and dumped into large vats where high-power fans circulate the air, inducing heat to aid the digester in speeding up the process by months. Once sterilized, the manure is packaged ready for use. With eight steel roofed pen buildings, the Ohio Feed lot, eliminates one problem or rural water pollution — runoff caused by an effluent of cattle feces and urine. The mixture of feces and urine gives off two gases, ammonia and carbon dioxide. To control the ammonia level, the buildings are placed to give a maximum drying and cooling effect. Natural air is maintained in the barns. The use of an enclosed environment has also completely self-sustaining environment—and a completely ecology-proof environment. (Cameron-East Central).

### 1677 - A8, A9, B1, D3 100

### FEED ADDITIVES FOR CONTROL OF HOUSE FLY LARVAE IN LIVESTOCK FECES

Fort Hays Branch
Kansas Agricultural Experiment Station
Hays
T. L. Harvey and J. R. Brethour.
Journal of Economic Entomology, Vol. 53, No. 5, p. 774-776, October, 1960. 4 tab, 12 ref.

Descriptors: *Feeds, *Larvae, *Farm wastes, *Livestock, *Cattle.
Identifiers: *Feed additives, *House fly larvae, *Feces, Musca domestica L.

This investigation was to test Polybor 3 as an additive to a steer ration for control of house fly larvae in feces. Control of house fly larvae was obtained in steer manure treated with Polybor 3 at one gm/kg but not at half this rate. Polybor 3 fed at rates up to 100 gm/head day to a steer weighing about 700 lbs., resulted in no significant control of house fly larvae in manure. Spores mixed directly with steer feces at a rate of 300 mg/kg prohibited fly development (egg to adult) and 100 mg/kg reduced it significantly. No effect on fly development was evident in manure treated at 30 mg/kg. The development of house flies was prevented in feces from a steer fed 30 gm of B. thuringiensis spores/day. Feed intake of this steer did not appear to be affected by including spores at this rate in the ration. Although the ration included 72 mg of aureomycin/day, this did not nullify the effect of B. thuringiensis on development of house flies in feces. Aureomycin did not decrease the pathogenicity of B. thuringiensis for house flies. (Cartmell-East Central).

### 1678 - A2, B2 300

### LOCATING A NEW FEEDLOT

Extension Agricultural Engineer
Nebraska University
Lincoln
E. A. Olson
Cooperative Extension Service Report GPE-5/01, University of Nebraska, Lincoln, 4 p. 5 fig.

Descriptors: *Feed lots, *Locating, Farm wastes, Water pollution, Livestock, Regulation, Zoning, Topography, Water supply, Transportation, Marketing.

The selection of a site for a livestock feedlot directly affects the success of the feedlot. Factors to consider in choosing a feedlot location include: environmental considerations, streams, topography, water supply, land area, towns and zoning laws. Other items include a source of livestock and feed, transportation (roads), and marketing facilities. Finally the operator must determine the size to build with provision for expansion. (Cartmell-East Central).

### 1679 - B2, E2 700

### TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION

P. H. Rath.
M. S. Thesis, Dept. of Agricultural Engineering, Iowa State University, 1966, 116 p. 6 fig, 2 tab, 72 ref.

Descriptors: *Waste treatment, *Waste disposal, *Livestock, *Lagoons, *Effluent, *Soils, Percolation, *Infiltration, Liquid wastes, Organic wastes, Water pollution, Permeability.
Identifiers: *Land disposal.

Treatment of liquid livestock wastes by soil percolation is a possible means of disposing of huge supplies of wastes. However, to be effective, soil percolation must deal with factors such as (1) the rate at which the wastewater can be applied without significant runoff, (2) the frequency of application most favorable to maintenance of the agronomic usefulness of the land, (3) the seasonal variation, (4) the degree of assurance that the quality of the ground water will be impaired due to excessive seepage, and (5) the equipment needed. In view of the information which has resulted from this investigation, it is evident that actual field applications of soil percolation will be necessary to determine if soil percolation is feasible or sound to use in the long run. However, this study gave promising results for soil percolation and no significant drawbacks were encountered. (Russell-East Central).

1680 - B2, E2 700

### EFFECT OF FEEDLOT LAGOON WATER ON SOME PHYSICAL AND CHEMICAL PROPERTIES OF SELECTED KANSAS SOILS

D. O. Travis.
P.H.D. Dissertation, Department of Agronomy, Kansas State University, Manhattan, 1970, 97 p, 12 fig, 26 tab, 93 ref.

Descriptors: *Feed lots, *Lagoons, *Soil chemical properties, Soil physical properties, Kansas, *Soil cores, Farm wastes, Waste disposal, Waste treatment, Irrigation, Infiltration rates, Nitrogen.
Identifiers: *Lagoon water, Dilution.

Cores from four Kansas soils were treated under unsaturated flow conditions with lagoon water collected as runoff from a Kansas State University experimental feedlot. This was done in order to determine the probable effects of applying such material to the soil as supplemental irrigation water and as a means of water disposal. Soil cores were collected and analyzed while in the natural state. Additional cores were collected and treated with the lagoon water. Changes in the infiltration rate while the lagoon water was percolating through the soil cores were measured and recorded. The resulting filtrates were analyzed for their chemical constituents during the duration of the experiment. An examination of these treated cores at the end of the experiment indicated a greatly increased monovalentcation concentration (especially Na) and an increased total nitrogen concentration within the soil resulting from the lagoon-water treatments. Dilution is proposed as a solution for this waste disposal problem. (Cartmell-East Central).

1681 - A1, B1, D1, E1 100

### ANIMAL WASTE MANAGEMENT-PROBLEMS AND GUIDELINES FOR SOLUTIONS

Department of Agricultural & Civil Engineering
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Ithaca, New York 14850
R. C. Loehr
Journal of Environmental Quality, Vol. 1, No. 1, p. 71-78, Jan.-March, 1972. 2 tab, 11 ref,

Descriptors: *Farm wastes, *Management, *Confinement pens, Livestock, Waste treatment, Waste disposal, Legal aspects, Liquid wastes, Solid wastes.
Identifiers: Animal wastes, *Guidelines, Land disposal.

Increased efficiency of agricultural production has caused new environmental problems for agriculture. Confined animal production operations produce large volumes of animal wastes for disposal. The most satisfactory solutions for animal wastes include some type of initial treatment (natural drying systems, aerated liquid systems, runoff control measures, waste holding units) followed by land disposal. The long term approach for animal production must be based upon both optimal production of the product and on maintenance of acceptable environmental quality not only to the animals and the producers, but to society as a whole. (Merryman-East Central).

1682 - B1, D1, E2 600

### POLLUTION ABATEMENT SYSTEMS FOR FARM ANIMAL WASTES IN SOUTHEAST MICHIGAN

Area Engineer
Ann Arbor, Michigan
B. E. Boesch and D. F. Kesselring
Presented at the 1973 Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-414, 13 p. 2 ref.

Descriptors: *Farm wastes, *Michigan, *Pollution abatement, *Waste treatment, *Waste disposal, *Waste storage, *Design, Equipment, Costs, Livestock, Feed lots, Lagoons, Irrigation, Construction costs.

Seventy-nine pollution abatement systems for farm wastes were installed in southeast Michigan during 1970 to 1972. The systems varied greatly in size, but they can be categorized into farm functions: diversion, collection, storage, and disposal, The systems used to perform these functions are discussed. Included in the discussion are: liquid manure tanks, holding ponds, semiliquid manure storage units, solid storage units, earthen holding pits, conventional manure-handling equipment, tanker wagons, and spray distribution systems. Actual design, construction, costs, and guidelines for these waste management systems are given. (Frantz-East Central).

1683 - A5, B1, D1 600

### PERFORMANCE OF EXPERIMENTAL CLOSE-CONFINEMENT (CAGED) CATTLE FEEDING SYSTEMS

Agricultural Engineering Department
Oklahoma State University
Stillwater
G. W. A. Mahoney, G. L. Nelson, and S. A. Ewing.
Transcript No. 67-405 presented at the 60th Annual Meeting, American Society of Agricultural Engineers meeting jointly with the Canadian Society of Agricultural Engineering, Sasakatoon, Saskatchewan, June 27-30, 1967, 20 p. 12 fig, 5 tab.

Descriptors: Performance, *Feed lots, *Confinement pens, *Cattle, Farm wastes, Waste storage, Waste disposal, Odor.
Identifiers: *Close confinement feeding systems.

The objectives of this test were to determine the performance of cattle in crowded housing and to develop design parameters for confined housing facilities for cattle. Cattle behavior, activities, and health were studied extensively. The following results were noted: (1) Cattle limited to 15 square feet of slatted floor space required 20 percent more feed per pound of gain than cattle allowed 25 square feet of slatted floor space, or cattle in dirt lots with 100 square feet of space per animal. Daily rate of gain was 20 percent and 34 percent less, respectively. (2) Some sore feet were noted on animals on concrete slotted floors but this condition seemed to pass without incident and no detrimental effects were noted. (3) No preference was shown by the animals for any particular grid slat and slot width configuration. All four combinations tested performed well, with the 1 3/4 inch slots performing best in freezing weather. The wide slat and slot configuration, 5 inch slat with 1 3/4 inch slot, was the most economical to construct. (4) Animal waste accumulated at the rate of 0.3034 cubic feet per head per day. When the liquid portion was allowed to drain out of the pits, the accumulation rate was 0.2212 cubic feet per head per day. However, the latter wastes proved difficult to pump and this practice, of draining the pits, would prove costly in both time and equipment in cleaning. (Wetherill-East Central).

1684 - B1, C2, C3 600

### OUTDOOR BEEF CATTLE FEEDLOTS —PROPERTIES OF MANURE ACCUMULATIONS

Department of Agricultural Engineering, Nebraska University, Lincoln
C. B. Gilbertson, J. R. Ellis, J. A. Nienaber, T. M. McCalla, and T. J. Klopfenstein.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 20 p. 5 fig, 5 tab, 11 ref.

Descriptors: *Farm wastes, *Feed lots, Chemical properties, Physical properties, Nebraska, Nitrogen, Phosphorus.
Identifiers: *Beef, *Manure, *Surface slope, *Animal density, *Climatic conditions, Volatile solids.

Outdoor beef cattle feedlots were constructed with 3, 6, and 9% slopes at the University of Nebraska Field Laboratory to study the characteristics of wastes. The results of this four year research show that the physical and chemical characteristiecs are affected by surface slope, animal density, and uncontrollable climatic conditions. The slope did not have a predictable effect on the average moisture content of material removed. Material was removed semiannually from the feedlot surface to the depth of the soil-manure interface. The total solids removed averaged 25 and 35% volatile for the 200 and 100 sq. ft./head lots, respectively. pH, nitrogen content, and phosporous content were also measured. Completely removal of material down to the soil-manure interface is not recommended because the large quantities of soil removed must be replaced. (Cameron-ECU)

1685 - A9, B2, D3 100

### SURVIVAL OF SALMONELLA TYPHIMURIUM IN ANIMAL MANURE DISPOSAL IN A MODEL OXIDATION DITCH

L. A. Will, S. L. Diesch, and B. S. Pomeroy, American Journal of Public Health, Vol. 63, No. 4, p. 322-326, April, 1973. 1 fig, 2 tab, 21 ref.

Descriptors: *Salmonella, *Farm wastes, *Livestock, *Waste disposal, *Oxidation lagoons, Cattle, Pathogenic bacteria, Model studies, Effluent, Sludge, Measurement.
Identifiers: *Survival, Seeding

In order to evaluate the potential health effects of pathogens in cattle manure, research was conducted in a laboratory model oxidation ditch to measure salmonella survival time, to develop and improve bacteriologic methods of measurement of detection and survival of pathogens in beef cattle manure, Salmonella typhimurium survived for 17 days post seeding in the model oxidation ditch at summer temperatures. The microorganism survived for 47 days at winter conditions. The data indicated that survival is of greatest duration in the sludge portion of the settling chambers. Based upon results obtained, the three sampling methods, temporary swab, prolonged swab, and increment removal, were comparable in isolations made. The greatest success for measuring survival thus far has been achieved utilizing BG—Bile and Selenite-BG-sufadiazine as the enrichment phase, and SS and Selenite-BG-sulfadiazine the plating phase for isolation, Perhaps one approach to controlling the salmonella problem in animal manures is to chlorinate, or otherwise treat, the wastee emanating from confinement housing units. (Cartmell-East Central).

1686 - A5, B2, D4 600

### AEROBIC TREATMENT OF POULTRY WASTES

J. H. Martin, R. C. Loehr, A. C. Anthonisen, and S. P. Nieswand.
Department of Agricultural Engineering, Cornell University, Ithaca, New York. ,
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 35 p. 10 fig, 6 tab, 11 ref.

Descripteors: *Aerobic tereatment, *Farm wastes, *Poultry, Oxidateion lagoons, Odor, Construction, Operation and maintenance ,Costs.
Identifiers: Oxidation ditch.

The relaetionship between fundamental concepts and design criteria for the aerobic treatment of poultry wastes are presented. The results of an evaluation of a full scale oxidation ditch system were used to illustrate this relationship and to characterize the potential of erobic treatment for these wastes in terms of construction and operating costs. The full scale oxidation ditch system that was evaluated is located on a commercial poultry farm approximately five miles north of Ithaca, New York. The farm is owned and operated by Mr. Charles Houghton. The system consists of two interconnected ditches that were evaluated as a total system. A plan-view and cross-section of the Houghton facility are shown. Throughout the course of study, the Houghton Farm oxidation ditches have achieved the objective of odor control. The absence of complete nitrification, i.e. no residual mixed liquor ammonia, except for a brief period indicated inadequate oxygenation capacity. It was determined in laboratory studies that nuirifying organisms were present. A summary of the capital and operating expenses associated witeh the Houghteon oxidation ditches are given. (Cartmell-East Central).

1687 - B2, D4, E2 600

### ABOVE GROUND STORAGE OF LIQUID MANURE

Department of Agricultural Engineering, Kentucky University, Lexington.
H. E, Hamilton, and I. J. Ross.

Descriptors: *Waste storage, *Liquid waste, *Design, Dairy industry, Operation and maintenance, Kentucky.
Idenetifiers: Liquid manure, *Above ground storage.

Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 12 p. 4 fig.
Two experimental above ground liquid manure storage systems were installed at the University of Kentucky dairy research center in order to determine theoperating characteristics and design critria for farm applications. The 82,000 gallon tanks were constructed of chromized steel sheets. The design is basically the same as that used for high moisture grain storage Conventional manure pumps were modified and installed in a collection pit. Valving was arranged to allow agitation in the collection pit, pumping into the storage tank, or pumping to a spreader. All the systems functioned well except the nozzles inside the tanks. (Cartmell-East Central).

1688 - B3, D4 100

### THE AEROBIC DECOMPOSITION OF SOLID BEEF CATTLE FEEDLOT WASTE

Martin, J. D.
M. S. Thesis, Texas Tech University, Lubbock, January, 1971, 30 p. 9 fig. 1 tab. 8 ref.

Descriptors: *Aerobic treatment, *Solid wastes, *Farm wastes, *Feed lots, *Cattle, *Waste treatment, Carbon, Nitrogen, Chemical oxygen demand, Decomposing organic matter, Temperatare, Moisture, Phosphorus, Odor, Digestion.
Identifiers: *Composting, Flies.

The objective of this study was to determine the feasibility of waste stabilization by aerobic decomposition. The feedlots from which beef cattle waste was recovered were located on the Texas Tech University agricultural farms in Lubbock, Texas. Four different lot treatments were used in the study. Temperature, moisture, carbon nitrogen ratio, and phosphorous content affected the rate of digestion. Under proper, effective management, beef cattle feedlot waste can be successfully composted reducing raw feedlot manure to an innocuous material of low energy potential. Odors, as well as fly and maggot infestations, cease shortly after the process begins. The optimum moisture range of manure to be composted is from 30 to 50% The C/N ratio should exceed 30 to obtain optimum composting rates. Aeration rates should be maintained between 3 and 6 liter/min. per 100 kg. of waste or regulated to yield an 8 to 10 percent oxygen level in the exhaust gases. (Cartmell-East Central).

1689 - B2, C1, D1, E2 700

### THE RENOVATION AND REUSE OF WATER FOR DILUTION AND HYDRAULIC TRANSPORT OF DAIRY CATTLE MANURE

R. E. Graves.
PhD Thesis, University of Massachusetts, Amherst, June, 1971, 120 p. 31 fig. 18 tab. 61 ref.

Descriptors: *Farm waste, *Cattle, *Dairy industry, *Water, *Hydraulic transportation, Water pollution, Chemical oxygen demand, Biochemical oxygen demand, Ammonia, Nitrates, Waste treatment, Liquid wastes, Phosphate, Chlorides, Slurries, Aerobic treatment.
Identifiers: *Renovation, *Reuse, *Dilution, *Screening.

Work was undertaken to evaluate the concept of pretreatment by screening combined with aerobic stabilization and reuse of water as they might apply to the hydraulic handling of dairy cattle manure. Performance of a stationary sloping screen for separating solid material from dairy manure slurries was evaluated using different bar spacings and different slurry mixtures. Two different systems were used to treat screen effluent. One system consisted of primary settling, aeration and final settling; the other of aeration and final settling. No adverse effects on the treatment systems were noted from the reuse of water. Screening of water-manure slurries removes a significant amount of material from the liquid and makes subsequent treatment and handling easier. Screen effluent may then be irrigated, stored aerobically, or treated to allow reuse for hydraulic cleaning. The addition of screening will improve the operation of many systems now used for treatment of animal manure slurries. (Russell-East Central).

1690 - A2, D3, E2 700

### ZETA POTENTIAL OF COLLOIDAL SUSPENSION FROM A BEEF CATTLE FEEDLOT SURFACE

J. C. Lorimor,
M. S. Thesis, Agricultural Engineering Department, University of Nebraska, 50 p. 12 fig. 12 tab, 29 ref.

Descriptors: *Zeta potential, *Feed lots, *Cattle, Runoff, Water pollution, Hydrogen ion concentration, Irrigation, Waste treatment, Sampling, Temperature, Statistical models.
Identifiers: *Colloidal suspensions, Quadratic equations, Alum.

Runoff from beef cattle feedlots is one source of potential water pollution. Two alternatives are available to prevent feedlot runoff from polluting streams: (1) the water can be spread on agricultural land as irrigation water, or (2) it can be treated before it is released to the streams. Zeta potentials on colloidal solids in feedlot water samples were investigated as one method of treatment control. Zeta potentials were found to average -20.5 millivolts on untreated samples. The potentials varied with pH and solids concentrations according to theory. Particle zeta potentials were found to be controlled by chemical treatments and high chemical dosages were required to reduce the zeta potentials to near the isoelectric point. Also, quadratic equations could be written to accurately define the relationships between zeta potentials, chemical dosages, and solids concentrations. (Russell-East Central).

1691 - B1, F1, F2, F4 200

### NEBRASKA UNIVERSITY SECOND NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT

Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, 265 p.

Descriptors: *Poultry, *Farm wastes, *Waste disposal, Lagoons, Odor, Legal aspects, Equipment.
Identifiers: *Waste management.

Waste management is an issue that the poultry industry must be prepared to deal with. This Second National Symposium did a great deal to inform the poultry industry of current waste management alternatives. As expected, lagoons were discussed extensively throughout the symposium. Many problems such as poultry waste disposal on the farm, in the hatchery, and in the processing plants were discussed. Hydraulic manipulation of wastes was presented along with considerations of proper odor control. Information concerning legal, social, and economic aspects of waste management were also dealt with. Much more study and research is needed so that the poultry industry can better deal with the problems and changes of the future. (Russell-East Central).

1692 - B2, C5, D4 200

### WASTE DISPOSAL CONCEPTS

Professor of Sanitary Engineering, Purdue University, Lafayette, Indiana.
D. E. Bloodgood.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 1-8.

Descriptors: *Waste disposal, *Farm wastes, *Poultry, *Lagoons, *Anaerobic digestion, Chemical properties, Design.
Identifiers: Loading rates.

The adoption of the anaerobic process for disposal of chicken manure in large production operations appears to be an excellent idea. Through the process of anaerobic digestion, the organic solids of the wastes are digested by anaerobic bacteria to ideally produce carbon dioxide and methane. Factors important in successful anaerobic digestion are: (1) pH; (2) alkalinity; (3) volatile acids; (4) nitrogen; (5) loading rates; and (6) temperature. Each of these factors is important in maintaining a proper balance in a lagoon. Lagoons can be constructed in a variety of shapes and sizes with a variety of methods for starting them initially. Poultry manure offers many variables to lagoon operation such as buildups of ammonium carbonate or hydrogen sulfide, and each lagoon will have a particular set of variables to deal with. More studies will be necessary to determine the lagoon's capabilities in digesting dead chicken feathers and chicken feeds. (Russell-East Central).

1693 - B2, D4 200

### PRINCIPLES AND PRACTICES OF AEROBIC TREATMENT IN POULTRY WASTE DISPOSAL: AEROBIC STABILIZATION PONDS

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.
R. Porges.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 23-42, 3 fig. 4 tab. 8 ref.

Descriptors: *Poultry, *Farm wastes, *Waste treatment, *Waste disposal, *Aerobic treatment, Design.
Identifiers: *Aerobic stabilization ponds, Loading rates.

Successful waste treatment envisages the economic handling of waste waters in such a fashion that public health and welfare will not be endangered; odor, insect, and esthetic nuisances will not be created; and legitimate water uses will be protected. Waste stabilization ponds are probably the best treatment tools for waters because they make use of natural biological reactions. In the aerobic type of ponds, algae produce oxygen which permits aerobic bacterial degradation of the organic material. Pond loading is an important factor which varies with climatic conditions. Pond size and depth are also variable. Estimates of aerobic pond capabilities state that one acre of an aerobic pond will provide adequate treatment of manure wastes from 3,000 chickens. More data is accumulating about aerobic ponds, and although they are not the answer in every case, they do provide the poultry farmer with a valuable and economic tool for waste disposal. (Russell-East Central).

1694 - A5, B1, D1 200

### ODORS AND THEIR CONTROL

Barnebey and Chaney, Columbus, Ohio.
O. L. Barnebey.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 57-65.

Descriptors: *Odor, *Control, *Equipment, *Poultry, *Farm wastes, *Waste treatment, Anaerobic conditions.
Identifiers: Feathers.

Odor is a perplexing and burdensome problem to the poultry farmer. It is difficult to solve and often expensive. There are five main problems to be dealt with to help curtail odors. The first is general housekeeping. The excrement from the poultry undergoes anaerobic reactions and noxious odors are produced which should be pumped into a digester. The second problem is feathers. The feathers should be promptly removed to eliminate buildup. The third problem is odor from cooking feathers and dryer gases. These odors or gases should be piped into scrubbing towers. The fourth problem is feather meal dust. This dust should also be piped to the scrubbing tower to remove odors. The fifth problem is holding ponds for the waste. This is the area most subject to public condemnation and should not be used if possible. After the problems are identified, the poultry farmer should then select the equipment which would best eliminate the odors from his particular operation. (Russell-East Central).

1695 - A5, B1, D1 200

### IDENTIFICATION AND CONTROL OF ODORS FROM ANIMAL WASTES

Livestock Farm Advisor, Agricultural Extension Service, California University.
C. A. Perry.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 67-73.

Descriptors: *Odor, *Control, *Farm wastes, Anaerobic conditions, Aerobic conditions, Feed lots, Cattle, Waste treatment.
Identifiers: *Animal wastes.

Animal wastes produce noxious odors when they undergo anaerobic digestion. On the other hand, little or no odor is produced by aerobic digestion. However, to accomplish aerobic digestion in a cattle feedlot, some sort of mechanical agitation must be employed. In Pomona, California, odor from two cattle feedlots outside of town was a source of complaint. To prevent legal problems, the feedlots began to remove accumulated wastes, to use chemicals to control odors, and to mechanically agitate wastes with a harrow to promote aerobic bacteria. An odor panel in Pomona was started to keep records of odors. The odor panel kept records for a year with few reports of feedlot odor during the last few months. Pomona now gets few complaints from citizens about feedlot odors. Good management is probably the most important factor in odor control. (Russell-East Central).

1696 - B2, D4 200

### ANAEROBIC LAGOONS: THEORY AND PRACTICE

Agricultural Engineering Research Division, Agricultural Research Service, United States Department of Agriculture.
H. J. Eby.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 77-91. 1 fig, 2 tab.

Descriptors: *Lagoons, *Anaerobic conditions, *Design, Biochemical oxygen demand, Waste treatment, Farm wastes, Sewage, Livestock.

The function of any lagoon, whether it be aerobic or anaerobic, is to reduce the BOD of the materials entering the lagoon. It is difficult to maintain a totally aerobic or anaerobic condition in a particular lagoon because so many variables exist which affect the microbial growth. Sewage treatment can be accomplished much more easily than farm waste treatment because sewage flow is regular and stable whereas the loading rate and flow of livestock waste is fluctuating and erratic. Recommendations for the proper design of an anaerobic lagoon are presented. These recommendations stress converting population equivalents to pounds of BOD. Also there are suggestions on the proper management and detention time of the lagoon. Research units have been devised to test the effectiveness of anaerobic lagoons in treating livestock wastes. (Russell-East Central).

1697 - A8, A9, D1, E1, F4 , 200

### SOCIAL AND LEGAL IMPLICATIONS OF ORGANIC WASTE MANAGEMENT

Chief, Division of Environmental Sanitation, California State Department of Public Health, Berkeley, California.
F. M. Stead.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 93-114.

Descriptors: *Organic wastes, *Management, *Legal aspects, *Public health, Environmental control, Waste treatment, Waste disposal.
Identifiers: Pollution.

In the past, Americans felt that the land was so vast and its resources were so great that nothing could ever overload the environment. Consequently, for years Americans poured wastes into the air, land, and water. Within the past few years, people have started to become aware that our natural resources must be protected. The environmental problem is extremely complex. Environmentalists have adopted the systems approach in hope of controlling the environment, because our resources such as water, air, and land must be preserved. The question is—who is to decide what shall be done? Should it be the courts, the people, or scientists? The legal aspects of curtailing pollution are unprecedented and difficult to establish, but they must be established. The environment must become regulated by man because it is dominated by man. Organic waste is essential and vital to man's existence, and the future holds dim prospects if man does not begin now to solve these problems. (Russell-East Central).

1698 - A5, B2, D4 200

### HYDRAULIC COLLECTION OF POULTRY WASTE

Department of Agricultural Engineering, Cornell University, Ithaca, New York.
D. C. Ludington, and A. T. Sobel.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 115-135. 5 fig, 1 tab.

Descriptors: *Poultry, *Farm wastes, Waste storage, Waste treatment, Odor, Design, Cleaning.
Identifiers: *Hydraulic collection, Storage pits.

Hydraulic waste control systems offer many possibilities to the poultry farmer. Hydraulic collection of wastes reduces odors and permits scheduled cleaning. Hydraulic systems reduce labor requirements, lower fly production, and give more uniform indoor temperatures. The biggest advantage of hydraulic waste control is flexibility in the cleaning system, but cleaning cannot be accomplished efficiently without mechanical assistance. The pits which contain the waste should be confined by walls and limited to three feet in depth for safety and ease of cleaning. As in most processes, the hydraulic system does have disadvantages. The major one is the amount of material that is handled. Since dilution is required, more material must be handled with the hydraulic system than with other systems. (Russell-East Central).

1699 - B2, D4, E2 200

### HYDRAULIC MANURE HANDLING IN LAYING HOUSES

Extension Poultryman, Cornell University, Ithaca, New York.
C. Ostrander.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 137-147.

Descriptors: *Hydraulics, *Farm wastes, *Poultry, *Waste treatment.
Identifiers: *Manure.

There is no one cure-all system of waste disposal that can be used in all poultry situations. However, it appears that hydraulic handling of liquid wastes will work satisfactoritly in many situations. Hydraulic collection provides flexibility in time of cleaning, reduction of odors, reduction of labor, reduction of mechanization, control of flies, and control of temperatures in the poultry house. The system itself is not a lagoon and does not reduce or digest the wastes. The main disadvantage is that the system does not dispose of the manure, and it must still be hauled away and spread on land. Hydraulic systems have no place in a poultry operation which involves dehydration or incineration. It appears, however, that the advantages greatly outweight the disadvantages in making the hydraulic handling of poultry manure an effective means of waste disposal. (Russell-East Central).

1700 - A5, B2, D4 200

### HYDRAULIC MANURE SYSTEMS

Chairman, Poultry Science Department, Nebraska University, Lincoln.
J. L. Adams.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 149-159. 1 fig, 1 tab.

Descriptors: *Hydraulics, *Waste treatment, Waste disposal, Odor, Design, Cleaning, Waste storage, Liquid Wastes.
Identifiers: *Manure, Fly control.

The need for good methods of waste storage, transportation, and disposal is greater than ever before. Hydraulic systems provide many answers to the poultry man's problems. Investigators have determined that poultry waste contains about 80% water; thus making it an excellent substance to be handled hydraulically. It has also been found that a simple diaphragm type pump is sufficient for moving large quantities of manure with up to 20% solids. Difficulties of hydraulic systems are the odors produced, the difficulty of disposing of the liquid manure after it has been collected. However, the advantages are flexibility of time of cleaning, ease of handling the manure, less possibility of noxious gases, control of flies, relatively inexpensive equipment, and control of constant temperatures. (Russell-East Central).

1701 - B2, C5, D4 200

### LIQUID HANDLING PROCESSES FOR POULTRY MANURE UTILIZATION

Agricultural Engineering Department, Massachusetts University, Amherst.
C. A. Johnson.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 161-181. 3 fig, 10 ref.

Descriptors: *Liquid wastes, *Waste treatment, *Waste storage, *Poultry, *Farm wastes, *Stabilization, Septic tanks.
Identifiers: *Manure.

An integrated system concept for liquid manure handling that has been operating for a year and five months is described. This system was designed for a 7000 bird cage layer flock on the Rolland Congdor Farm in Longmeadow, Massachusetts. The system involves flushing the manure from under the cages to a large heated septic tank. The effluent from the septic tank is recycled to eliminate high water usage. This system provides ease of handling the manure. There are few moving parts with only a pump and motor operating about 30 minutes per day. No noxious odors are produced, and there is no manure accumulation pit or buildup. Water usage is relatively small since the effluent is recycled. Disposal of the manure is simple and seldom because a tank wagon can replace spreaders and irrigation systems can replace batch handling. Also the system is economical. The floating scraper and small pump can replace about $4,000 or more worth of mechanical cleaning equipment. With slight design changes and further experiments, it is hoped that this liquid manure system will become very profitable to use. (Russell-East Central).

## 1702 - A1, B2, D4 200
## LAGOONS—SINK OR SWIM
Brender's Leghorns, Ferndale, New York.
M. Brender.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 183-192.

Descriptors: *Lagoons, *Farm wastes, *Poultry, *Waste storage, *Waste treatment, Odor.

"Indoor" and "outdoor" "lagooning" are two methods often employed by poultry farmers for waste storage and treatment. With either type, the poultryman fights an odor problem. To prevent odor and to beneficially handle manure, the poultry man should catch manure in waterproof tanks; keep it covered with water at all times; move it out before it settles down; either haul it and spread it on crops or stabilize it in an outdoor lagoon; and move wastes by gravity. The author predicts that present and future research will solve many of the current lagoon odor, decomposition and pollution problems. (Russell-East Central).

## 1703 - A9, B1, C5, E1 200
## HEALTH ASPECTS OF POULTRY WASTE DISPOSAL
Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio.
C. W. Chambers, and N. A. Clarke.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska Lincoln, May 19-20, 1964, p. 193-212. 18 ref.

Descriptors: *Farm wastes, *Waste disposal, *Public health, Bacteria, Fungi, Viruses, Diseases.

Interest in the disposal of poultry waste has stirred interest in the health aspects of poultry waste disposal. Many diseases are possibly communicable to man from poultry wastes. These diseases are caused usually by bacteria, fungi, or viruses. There are many avenues of transmission of the disease, such as direct contact with waste; ingestion of waste; inhalation of waste; and direct or indirect contact with vectors such as insects. Many diseases, such as those caused by the Salmonella species, can be transferred to man. To prevent the spread of disease, the poultry farmer should attempt to control conditions which result in multiplication of disease-producing organisms. The source of the disease-production should be eliminated if possible. The waste should be processed in a way which would breakdown the chain of infection. Above all, the poultry farmer should practice good management and remain rational about the subject of disease and disease potential. (Russell-East Central).

## 1704 - A1, B1, F1, F2, F3 200
## SOCIAL, LEGAL, AND ECONOMIC CONSIDERATIONS OF ANIMAL PRODUCTION IN URBANIZED AREAS
Planning Director, Omaha, Nebraska.
A. Aust.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 225-240.

Descriptors: *Poultry, *Management, *Legal aspects, *Economics, *Urbanization.

Within the last forty years, our country has undergone extensive urbanization. The poultry farmer or industrialist must face the ever growing urbanization of our society to effectively function in the world of today and tomorrow. There are three social developments which have been accentuated by urbanization that restricts the location of animal processing plants. These are: (1) the growth of large concentrations of people crowded together; (2) the tremendous technological advances of our society; and (3) the growing affluence, education, and cultural sophistication of our society. Because of these social changes many legal developments have taken place in the past few years. New legal restrictions or controls on the animal industry usually fall into four main categories: (1) planning controls; (2) public health controls; (3) public safety codes; and (4) aesthetic controls. Closely related to social and legal developments are the economic considerations affecting the locating of new processing plants and the operation of existing plants. There are three courses of action open to the poultry industrialist in terms of economics. These are: (1) the laissez-faire or do-nothing approach; (2) the self-sufficient approach; and (3) the good citizen approach is economically the best approach to the poultry man. (Russell-East Central).

## 1705 - A1, B1, F4 200
## WHERE DO WE GO FROM HERE?
Extension Poultry Scientist, Federal Extension Service, United States Department of Agriculture, Washington, D.C.
W. R. Jenkins.
Second National Symposium on Poultry Industry Waste Management, University of Nebraska, Lincoln, May 19-20, 1964, p. 243-250.

Descriptors: *Poultry, *Waste disposal, *Water pollution, *Farm wastes, Research.

The future of the poultry industry is dependent on many factors. One of the most important factors that the poultry industry must deal with is proper waste disposal. Much has been dealt with in this symposium, but the poultry farmer should not mislead himself by believing that he has all of the answers. In the future, there will be increased concern about contamination of by-products, high quality water, and the disposal of large quantities of water. New and better systems of disposal will be devised, and it is hoped that the future will be bright for the poultry industry. (Russell-East Central).

## 1706 - A2, C2, C3 700
## WATER QUALITY OF STORM RUNOFF FROM A TEXAS BEEF FEEDLOT
G. G. Wise III.
MS Thesis, Department of Agricultural Engineering, Texas A&M University, August, 1972, 166 p. 34 fig, 79 tab, 28 ref.

Descriptors: *Water quality, *Storm runoff, *Texas, *Feed lots, *Cattle, Sampling, Equipment, Chemical oxygen demand, Phosphorus, Nitrogen, Potassium, Sodium, Chloride, Slope, Waste treatment, Water pollution.

One of the major sources of pollution from high density beef feedlots is storm runoff. Efforts were made to determine the variation in chemical and physical properties of storm runoff from a beef feedlot area of Texas and to correlate the water quality variations with storm characteristics and hydrologic properties of the feedlot drainage area. The average concentrations of water quality parameters in the feedlot runoff did not change as much with variations in rainfall intensities, runoff rates, and runoff volumes as indicated by similar runoff studies. The concentrations of COD, phosphorus, and Kjeldahl nitrogen in the runoff were directly related to the total solids concentration. The concentrations of filterable solids, potassium, sodium and chloride were greater when the contact time between the surface and the runoff was increased. The higher average concentrations of total solids, COD, phosphorus, and Kjeldahl nitrogen, and lower average concentrations of filterable solids, potassium, sodium, and chloride from one area was due to the greater slope causing an increased sediment load and decreasing the contact time between the runoff and the feedlot surface. (Russell-East Central).

## 1707 - B2 700
## AN ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL FROM CONFINEMENT FINISHING HOGS
R. P. Kesler.
MS Thesis, Agricultural Economics Department, University of Illinois, 1966, 97 p. 6 fig. 30 tab. 36 ref.

Descriptors: *Economics, *Evaluation, *Liquid wastes, *Confinement pens, *Hogs, Lagoons, Waste disposal, Nitrogen, Illinois, Fertilizers, Costs, Equipment, Sampling, Analysis.
Identifiers: *Manure, *Hauling and spreading, Pollution.

Manure is a valuable by-product of the hog industry. When applied to cropland, the chemical, physical, and biological properties of the soil are improved. Animal wastes must be removed from confinement buildings if production is to continue, and this study dealt with three types of waste removal: (1) total hauling and spreading; (2) partial hauling and spreading and lagooning; (3) total lagooning. Based on the finding of this study, the conclusion can be made that total hauling and spreading and lagooning is the lowest net cost method of manure disposal. Partial hauling and spreading and lagooning is the second lowest net cost method of manure disposal, and total lagooning is the highest net cost method of disposal. Another conclusion is that the net cost of manure disposal, for all three methods, declines as the volume of hog production increases. The choice between hauling and spreading manure is still in the innovative stage of development. However, when cropland is available for utilizing the salvaged value of the manure as a replacement for commercial fertilizer, there appear to be strong economic considerations favoring the hauling and spreading method for disposal of hog wastes. (Russell-East Central).

## 1708 - B2, D4, E2 700
## SOIL PERCOLATION AS A RENOVATION MEANS FOR LIVESTOCK LAGOON EFFLUENT
J. K. Koelliker.
MS Thesis, Department of Agricultural Engineering, Iowa State University, 1969, 108 p. 13 fig. 30 tab. 38 ref.

Descriptors: *Soils, *Percolation, *Livestock, *Lagoons, *Effluent, *Farm wastes, *Sprinkler irrigation, *Waste treatment, *Waste disposal, *Waste water treatment, Soil profiles, Hogs, Moisture, Chemical oxygen demand, Nitrogen, Phosphorus, Chlorides, Tile drains, Sampling, Iowa, Anaerobic conditions, Hydrogen ion concentration, Analysis.

A field experiment was operated from June through September, 1968, in central Iowa to study the use of a grass covered, Clarion-Webster silty clay loam soil profile as a treatment media for anaerobic manure lagoon effluent applied by sprinkler irrigation equipment. Effluent was applied at four loading rates—1.5 and 3.0 inches at 70% available soil moisture and 1.5 and 3.0 inches at 80% available soil moisture. Samples were collected on the surface, 3, 6, 12, and 30 inches deep in the soil profile, as well as from water flowing from the tile drains in each plot. Reduction in COD concentration was about 80% between the surface and the tile drains. Nitrogen concentration reduction was about 80%. Phosphorus concentration reduction was 80% in the top 3 inches of soil. The chloride concentration in the tile drainage water was reduced about 30%. The pH was reduced from 7.8 to 7.2 as the liquid percolated through the soil profile. No gross changes were observed in the soil where lagoon effluent was applied. The results indicated that a soil profile is an excellent treatment media for anaerobic lagoon effluent. (Cartmell-East Central).

1709 - B1, C3, C5, D4 600

### NUTRIENT CHANGES IN POULTRY EXCRETA FERMENTED WITH RUMEN BACTERIA

Department of Agricultural Engineering, University of Kentucky, Lexington.
H. E. Hamilton, I. J. Ross, J. D. Fox, and J. J. Begin.
Presented at 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972. Paper No. 72-434. 18 p. 8 fig. 1 tab. 12 ref.

Descriptors: *Nutrients, *Farm wastes, *Poultry, Fermentation, Nitrogen, Hydrogen ion concentration, Anaerobic conditions.
Identifiers: *Poultry excreta, *Rumen bacteria, Uric acid, Inoculum, Ether extract, Ash, Solids levels, Manure.

Proximate components and uric acid were measured in poultry excreta during anaerobic fermentation with rumen fluids as an inoculum. Nitrogen, ether extract, and ash were affected by pH and solids levels. There was an increase in the ether extract index at lower solids levels than for higher solids. Increasing the solids level or lowering the pH delayed the decomposition of uric acid. The uric acid was virtually decomposed after 30 hours at pH levels of 6.8 and 7.3 and 5 percent solids. The nitrogen, ether extract, and ash were also affected by the length of the fermentation period. (Cameron-East Central).

1710 - A2, B1, C1, D1, E1 600

### MONITORING ON-FARM WASTE MANAGEMENT SYSTEMS

Extension Agricultural Engineer, Iowa State University, Iowa.
S. W. Melvin, D. R. Vanderholm, and J. C. Lorimor.
Presented at 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, 1973. Paper No. 73-4542. 8 p.

Descriptors: *Monitoring, *Farm wastes, *Management, Hogs, Cattle, Feed lots, Runoff, Odor, Costs, Livestock, Corn Belt, Iowa.
Identifiers: Beef.

Research and demonstration sites were established to study waste management alternatives applicable in the Corn Belt. These sites were all commercial livestock operations including a wide variety of feed and waste handling systems. Among the data collected were runoff quality and quantity, waste characteristics, climatic data, cost data, and operating characteristics and problems. Results of the study showed that regular cleaning and maintenance of a low stocking rate in open feedlots results in pollutional strength of retained feedlot runoff of nearly 1/10 the pollutional strength of lots seldom cleaned, heavily stocked, and heavily packed with manure. Most debris basins or settling channels required a stabilized bottom of concrete or gravel to allow proper cleanout and maintenance. These sites have proved to be valuable resources in the animal waste management educational program carried on by Iowa State University extension staff. (Cameron-East Central).

1711 - B1, C3, D4 600

### ANAEROBIC DIGESTER RESPONSE WITH DAIRY CATTLE MANURE

Agricultural Engineer, Chicago Sanitary District.
J. L. Halderson, A. C. Dale, and E. J. Kirsch.
Presented at 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14. Paper no. 73-4532. 15 p. 6 fig. 2 tab. 21 ref.

Descriptors: *Anaerobic digestion, *Dairy industry, *Cattle, *Farm wastes, Chemical characteristics, Design.
Identifiers: *Manure, *Substrate, *Loading rates.

This study investigated the dynamic response of anaerobic digestion when that system was subjected to several levels of step rate changes in loading. Laboratory sized, four liter digesters, constructed of acrylic, maintained at 35°C, and continuously mixed were used to investigate the response when dairy cow fecal matter was the substrate. The units were batch fed once per day, with a 15 day detention time being maintained throughout the experiment. Dependent parameters measured were pH, total and volatile solids, total alkalinity, COD, gas production and composition, and total volatile acid concentration and composition. The experimental design consisted of a randomized block design with four factors and five levels of treatment. The fixed loading levels were considered to be the treatment with all other factors being held constant when possible. Individual digesters were nested within digester pairs and treatments. Results indicated that the biological system could respond in a satisfactory way to any of the applied tests of loading rates of waste. There were no strong indications that maximum loading rates or a maximum magnitude of step had been achieved. The responses of all the measured parameters are listed. (Russell-East Central).

1712 - A1, B3, E2 600

### MOVEMENT OF MANURIAL NITROGEN IN COOL, HUMID CLIMATES

Agricultural Engineering Department, Cornell University, Ithaca, New York.
M. F. Walter, G. D. Bubenzer, and J. C. Converse.
67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974. Paper No. 74-2018. 21 p. 10 fig. 4 tab. 14 ref.

Descriptors: *Model studies, *Nitrogen, *Nitrates, *Movement, *Anaerobic conditions, *Climates, *Farm wastes, Temperatures, Dairy industry, Crops, Ammonification, Nitrification, Denitrification, Soil moisture, Solutes.
Identifiers: *Manure, Ammonia volatilization, Ammonium fixation.

A quantitative computer model was developed to predict the vertical nitrate soil distribution resulting from heavy land applications of anaerobic liquid dairy waste applied to coarse textured soil. Parameters used in the model were developed for (1) soil with a deep water table, (2) soil temperatures of 0 to 20°C, and (3) soil matric potentials of 0 to -0.3 bars. Nitrogen immobilization, ammonification, and nitrification were the primary transformations found to occur in the soil system. The two dominant forms of inorganic nitrogen found in these soil systems were ammonium and nitrate. Nitrate movement was based on predicted one-dimensional unsaturated flow and solute dispersion. Dispersion was assumed dependent on solute displacement but not on soil water velocity. (Cameron-East Central).

1713 - A1, B1, C1, D1, E1, F1, F2, F4 600

### ANIMAL WASTE MANAGEMENT CONFERENCE

Iowa State University.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971.

Descriptors: *Farm wastes, *Management, *Livestock, *Confinement pens, *Waste treatment, *Waste storage, *Waste disposal, *Feed lots, *Economics, *Legal aspects, Lagoons, Runoff.

This conference was held in order to give an overview of animal waste management alternatives as they are practiced nationally, regionally, and by state. Animal waste characteristics, waste treatment facilities, waste disposal methods, and open lots vs housed confinement all come under close scrutiny. Legal and regulatory aspects of confinement are discussed. Activities of the Environmental Protection Agency, Soil Conservation Service, Agricultural Stabilization and Conservation Service, and Iowa Water Pollution Control Commission are discussed as well. (Merryman-East Central).

1714 - B1, F1, F2, F3, F4 600

### ANIMAL WASTE MANAGEMENT—COMMENTS ON THE NATIONAL SITUATION

Industrial Specialist, Environment Improvement, Agricultural and Natural Resources Division, Extension Service, United States Department of Agriculture.
K. R. Majors.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 7 p. 2 tab.

Descriptors: *Farm wastes, *Management, *Livestock, Feed lots, Confinement pens, Economics, Legal aspects, Technology.
Identifiers: *Animal wastes.

The character and magnitude of the problem of animal waste management; the impact of waste management and requirements of pollution control now mandatory for livestock producers; and the waste-management phase of livestock production are discussed. Agriculture does rank high as a generator of wastes—from both animal and crop production—but agriculture is unique in that it makes use of biological procedures almost entirely. The total animal waste figure is generally placed around two billion tons per year, or 5.5 million tons per day. Confinement housing systems for all animal production with quite different waste management systems than those for feedlots, must handle the same amount of waste per animal. Waste management and pollution control have become a concern in the livestock marketing system as well. Discussed briefly are various basic aspects of waste management including: technological requirements; regulatory requirements; economic factors; and social, political, legal, and related factors. Additional funds, expansion of activities, shifts in program emphasis, legislation for waste control, and cost sharing and broadening of provisions for financial assistance for feedlot operators are the key items desired by governmental agencies in order to make their programs more effective. (Cartmell-East Central).

1715 - A2, A5, B1, F4 600

### THE STATE AND REGIONAL SITUATION

Extension Agricultural Engineer, Iowa State University, Ames.
S. W. Melvin.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 9 p. 6 tab.

Descriptors: *Feed lots, *Confinement pens, *Farm wastes, *Livestock, *Management, Water pollution, Odor, Fishkill, Runoff.
Identifiers: *Midwest, *Corn Belt.

The Midwest is now and will continue to be a great livestock-producing area in the future. Waste management problems have resulted from increased densities of animals in confinement. The water pollution hazard of many animal production units has been recognized. Regulations for control of this problem presently exist in most of the midwestern states. Odor is still a problem to many producers. The technology of animal waste management must develop rapidly to solve many of the producers' problems. (Cartmell-East Central).

1716 - B1 600

### BIOLOGY OF WASTE MANAGEMENT

Department of Agricultural Engineering, Iowa State University, Ames.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 4 p. 2 fig.

Descriptors: *Biology, *Wastes, *Management, *Microorganisms, Bacteria, Algae, Protozoa, Metabolism.

This outline on the biology of waste management was prepared as a study aid for registrants at the Iowa State University Animal Waste Management Conference. The main topics of this outline were: bacteria, algae, protozoa and larger animals, bacterial physiology, population dynamics, environmental factors, food sources, hydrogen ion concentration (pH), trace nutrients, and temperature. (Cartmell-East Central).

1717 - A5, B2, D2, D4, F1 600

### AEROBIC WASTE TREATMENT

Department of Agricultural Engineering, Illinois University, Urbana.
D. L. Day.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 14 p. 3 fig. 6 tab. 4 ref.

Descriptors: *Farm wastes, *Waste treatment, *Aerobic conditions, *Oxidation lagoons, *Aerated lagoons, Municipal wastes, Design, Odor, Costs, Livestock.

Several forms of aerobic treatment relative to use in municipal waste treatment plants and adaptations for treatment of livestock metabolic wastes are discussed. Aerobic lagoons may be divided into two classifications, dependent upon the method of aeration: oxidation ponds (naturally aerated lagoons) and aerated lagoons (mechanically aerated lagoons). An oxidation pond is usually a shallow basin 3 to 5 feet deep for the purpose of treating sewage under climatic conditions (warmth, light, and wind) that promote the introduction of atmospheric oxygen and that favor the growth of algae to produce oxygen. An aerated lagoon is one that has a device that beats or blows air into the water with a portion of the oxygen being dissolved. The oxidation ditch is a modified form of the activated-sludge process. Aerobic bacteria use the organic matter in the waste as food for their metabolic processes, thus reducing the biologically degradable organics to stable material, with carbon dioxide and water as the major by-products. Design recommendations for in-the-building oxidation ditches are given. Some form of aerobic treatment is likely to be used in livestock waste management schemes because of the low level of odors associated with this method of treatment. (Cartmell-East Central).

1718 - B1 60C

### SYSTEM COMPONENTS TO SEPARATE SOLIDS AND LIQUIDS

Agricultural Engineering Department, North Dakota State University, Fargo.
G. L. Pratt.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 7 p. 3 fig.

Descriptors: *Solid wastes, *Liquid wastes, *Separation techniques, *Waste treatment, Feed lots, Livestock, Settling, Filtration, Centrifugation, Slurries.
Identifiers: Gravity flow.

The separation of solids from the liquid component of livestock manure adapts to many waste treatment and handling systems. Separation of these components is being introduced into systems where the material is separated prior to treatment as well as after the combined materials have undergone a treatment process. Two general methods are being used to accomplish the separation of manure components. These are settling and mechanical separation. In all devices that are used to settle solid materials from the liquid component of livestock waste, the velocity of flow of the liquid solid slurry is retarded to the point where sedimentation can occur. Concrete tanks and earth dugouts are being used for settling containers for the manure slurries. For runoff from feedlots, segregating the solid material from the liquids may be accomplished by settling channels. Mechanical separation includes filtration and centrifugation. Filtration of the combination solid liquid waste from livestock systems can often be designed to provide satisfactory installations. Advantages of the centrifuge are given. Gravity flow of liquids away from the solid manure is being investigated. Equipment improvements must be perfected before the system can be recommended. (Cartmell-East Central).

1719 - B1, D1 600

### SWINE MANURE COLLECTION AND REMOVAL SYSTEMS

Extension Agricultural Engineer, Iowa State University, Ames.
L. D. Van Fossen.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 6 p.

Descriptors: *Hogs, *Farm wastes, Confinement pens, Labor, Hydraulic transportation, Lagoons, Cleaning.
Identifiers: *Swine, *Manure, *Collection, *Removal, Stockpiling, Slotted pits, Flushing tanks.

This publication outlines collection and removal systems for swine manure. The topics considered are: (1) hand cleaning, (2) mechanical cleaning, (3) pumps and stockpiling, (4) moving manure with a hydraulic head, (5) manure storage in the building, and (6) hydraulically handling manure. (Cartmell-East Central).

1720 - A2, C1 600

### NATURE AND BEHAVIOR OF MANURE

Department of Agricultural Engineering, Iowa State University, Ames.
J. R. Miner.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 8 p.

Descriptors: *Farm wastes, *Water pollution, *Feed lots, *Runoff, Odor, Organic matter, Biochemical oxygen demand, Chemical oxygen demand, Nutrients, Microorganisms, Hogs, Gases, Confinement pens.
Identifiers: *Manure.

This outline was prepared as a study aid to the registrants at the Iowa State University Animal Waste Management Conference. The major topics outlined are: (1) Manure as a potential water pollutant, (2) Feedlot runoff, and (3) Odor. (Cartmell-East Central).

1721 - A2, B2, C3, D1, E2 600

### DESIGN CONSIDERATIONS IN FEEDLOT RUNOFF CONTROL

Extension Agricultural Engineer, Iowa State University, Ames.
S. W. Melvin.
Animal Waste Management Conference, Iowa State University, October 13-15, 1971, 5 p.

Descriptors: *Feed lots, *Runoff, *Control, *Design, *Farm wastes, Chemical characteristics, Waste disposal, Waste treatment, Iowa.

This outline of feedlot runoff pollution and control defines the following: (1) feedlot runoff, (2) problems caused by feedlot runoff, (3) factors affecting feedlot runoff quality, and (4) component design of runoff control facilities. Suggestions for minimizing feedlot complaints are listed. (Cartmell-East Central).

1722 - B1, C1, D4, E2 600

### WASTE MANAGEMENT SYSTEMS FOR ROOFED BEEF CONFINEMENT FACILITIES

Agricultural Engineering Department, Minnesota University, St. Paul.
J. A. Moore.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971. 6 p. 1 fig, 1 tab.

Descriptors: *Farm wastes, *Management, *Cattle, *Confinement pens, Performance, Oxidation lagoons, Liquid wastes.
Identifiers: *Roofed beef confinement, *Waste management systems, Pollution control.

The major objectives considered when discussing a waste management system are pollution control, saving of labor, and an increase in animal productivity. The system may be divided into four components: collection, storage, treatment, utilization and/or disposal. In the discussion of roofed beef confinement, the facilities are divided into three categories: (1) environmental conditions (cold and warm units), (2) floor type (solid or slatted), and (3) moisture content of the waste (less than 1% to over 50% total solids.) The right types of confinement facilities discussed are dry solid cold, dry solid warm, dry slatted cold, dry slatted warm, liquid solid cold, liquid slatted cold, liquid solid warm, and liquid slatted warm, Climate has a direct relationship upon the selection of these systems. By listing objectives, properties of waste material, and the design of the system, an optimum design can be obtained. (Cameron-East Central).

1723-B1, D1, E1 600

### SWINE SYSTEMS FOR IOWA AND NORTH CENTRAL STATES

Extension Agricultural Engineer, Iowa State University, Ames.
L. D. Van Fossen.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 3 p.

Descriptors' *Hogs, *Farm wastes, *Management, *Iowa, Environmental control, Confinement pens, Waste storage, Waste disposal, Arrangement.
Identifiers: *North Central States, *Swine.

Before building a swine facility, the producer must compare the features of the alternate systems in order to select the ones most appropriate for his needs. The goal to develop successful swine facilities is to minimize extreme and uncomfortable environmental stress conditions that adversely effect pig performance; utilize natural pig habits to properly select the building features and operate the facility; and provide convenience for the swine producer. Items to be considered are: (1) level of environmental control, (2) environmental modifying systems, (3) manure collection and removal systems, (4) manure disposal systems, (5) feeding systems, (6) pen size, (7) animal and man access, (8) arrangement, (9) pen partitions, (10) building location, and (11) operating the system. (Cartmell-East Central).

1724-A2, B1, E2 600

### WASTE APPLICATION TO SOILS

Graduate Assistant in Agricultural Engineering, Iowa State University, Ames.
J. K. Koelliker.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 8 p.

Descriptors: *Farm wastes, *Application methods, *Soils, Fertilizers, Economics, Waste disposal, Water pollution, Nutrients, Bacteria, Odor, Soil contamination, Groundwater pollution, Denitrification.
Identifiers: Land spreading, Surface water pollution.

Manure disposal can cause air, water, or soil pollution. Air pollution may be caused by odors emitted during spreading or from manure left uncovered following spreading. Air pollution during spreading can be avoided by spreading only when meteorological conditions are favorable for good air mixing and when the wind will dissipate odors into an unpopulated area. Direct injection of liquid manure can eliminate nearly all odor during spreading. Surface water pollution is caused by inadequate incorporation of manure into the soil surface. Consequently, runoff from this soil may result in excessive organic load, excessive nutrients, and possible bacterial contamination of streams and lakes. Spreading on steep slopes, frozen or snow-covered ground, or flood plains should be avoided unless incorporation can be done immediately. Groundwater pollution may result from excess nitrogen and from bacterial contamination from farm wastes. Soil contamination may also result from manure disposal. Heavy manure applications can result in anaerobic conditions caused by rapid decomposition and excess soil water. Design criteria and recommendations are given for combatting these pollution problems. (Cartmell-East Central).

### 1725-B3, D1, E3 600

### ANIMAL WASTE REUSE

Extension Veterinarian, Iowa State University, Ames.
J. B. Herrick.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 4 p.

Descriptors: *Farm wastes, *Recycling, *Feeds, *Poultry, *Cattle, Proteins, Insecticides, Costs, Additives.
Identifiers: *Animal wastes, *Refuse, *Refeeding, Disease spread.

A great deal of concern is being generated over animal waste reuse or recycling. Animal scientists and agricultural engineers are scheming elaborate and complicated systems to reuse animal wastes. Recycling animal manure into feeds has provided one answer. While such feeds have been shown to have nutritional value, other factors need to be considered. The use of drugs, hormones, and antibiotics on the animals may have significant effects on animal wastes. Insecticides are sometimes present in manure to be refed to animals. The problem with animal waste reuse centers around cost; disease spread; and the effect feed additives will have on the animal when waste is reused. (Cartmell-East Central).

### 1726-B1, C5, D1 600

### EFFECT OF HOUSED CONFINEMENT ON ANIMAL PERFORMANCE

Extension Livestock Specialist, Iowa State University, Ames.
W. G. Zmolek.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 6 p. 4 tab.

Descriptors: *Confinement pens, *Cattle, *Performance, *Farm wastes, *Waste storage, Waste treatment, Runoff, Labor, Costs.
Identifiers: *Housed confinement, *Floor types.

At several experimental locations, individual facilities are in operation that control or modify the environment of beef cattle. From the data reviewed, it has been concluded that the housing of feedlot cattle increases their daily gain and decreases their feed requirements. Furthermore, there is little, if any, difference in cattle response to different types of housing and floor types. Therefore, the waste handling system selected will dictate the type of floor to use more than animal performance. Housed systems will continue to grow in use because of the several side benefits they offer. Some of these are: surface runoff of waste is eliminated; slotted floors eliminate the cost of bedding and labor; protection from sun and rain maintains the fertilizer value of the waste; less labor is needed to handle manure; cattle are more docile and easier to handle; less land is needed and site development is easier; less labor is required in yard repairs; cattle are cleaner; hired workers take more pride in a confined operation; and less labor is required for feeding and management. (Cartmell-East Central).

### 1727 - B1, E1,F1 600

### ECONOMIC CONSIDERATIONS INVOLVED IN SELECTING TYPES OF CONFINEMENT AND WASTE DISPOSAL SYSTEMS FOR SWINE AND BEEF

Professor of Economics, Iowa State University, Ames.
E. G. Stoneberg.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 5 p.

Descriptors: *Economics, *Confinement pens, *Waste disposal, *Hogs, *Cattle, Costs.
Identifiers: *Swine, *Beef, Environmental standards.

Some of the critical factors which influence the selection of types of confinement and waste systems are presented. The use of confinement systems in beef or swine production substantially increases the capital investment within the enterprise. Because of the high capital requirements of confinement systems, consideration must be given to the potential advantages and disadvantages of this investment and to some of the characteristics of the investment. Although there are wide variations in the investment per animal unit capacity in confinement systems, observation indicates that the average investment per head of annual capacity in a cattle confinement system is normally in the range of $75 to $150. This does not normally include feed storage or processing facilities and may not include feed distribution equipment. The annual ownership costs of a confinement facility will probably fall in the range of 13 to 20 percent of the original cost. Any type of confinement system for pork or beef production requires some provision for animal waste disposal. Environmental standards for disposal of animal wastes may change the structure of the swine and beef industries if these standards are very severe. (Cartmell-East Central).

### 1728 - A1, B1, F1, F2 600

### LEGAL ASPECTS OF LIVESTOCK PRODUCTION AND WASTE MANAGEMENT

Professor of Economics, Iowa State University, Ames.
N. E. Harl.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 11 p.

Descriptors: *Legal aspects, *Livestock, *Farm wastes, *Management, Economics, Costs, Ethics, Negligence, Trespass.
Identifiers: *Production, *Pollution, Nuisance laws, Registration.

Pollution is an economic problem. Three basic approaches are possible to shift the external costs back onto the pollutor. Develop an ethic of environment preservation; create appropriate economic incentives or disincentives to achieve a desired behavior pattern; or impose legal regulations or legal sanctions to circumscribe undesirable behavior patterns. The idea of an environmental ethic is unlikely to be sufficiently effective to improve environmental quality at an acceptable pace. Most ethical standards relied upon by society have come to be backed by the force of law. The concept of taxes or charges on those polluting to (1) encourage substitute production methods that are less harmful to the environment, (2) increase the cost to consumers of products having an adverse effect upon the environment with the result that consumers tend to consume more of the less harmful products, and (3) generate revenues to fund public efforts to improve environmental quality holds considerable economic appeal, although relatively little use has been made of this approach in the past. It has become abundantly clear that the rights inherent in land ownership do not sanction or protect activities contributing to environmental pollution. Livestock producers must recognize that fact or face serious legal difficulty either through private litigation, public response to violation of environmental quality standards, or both. (Cartmell-East Central).

### 1729 - A1, F1, F3 600

### EPA'S ROLE IN THE ANIMAL WASTE PROBLEM: PANEL DISCUSSION

Rural Environmental Assistance Program Specialist, Agricultural Stabilization and Conservation Service, United States Department of Agriculture.
H. Andrew.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 6 p.

Descriptors: *Farm wastes, *Farms, *Costs, *Federal government, Pollution abatement, Iowa.
Identifiers: *Environmental Protection Agency, *Animal wastes, *Federal programs.

Agricultural Stabilization and Conservation Service, an agency of the United States Department of Agriculture, administers several programs. Included are loans to farmers on corn, soybeans, and other farm produced commodities; loans for storage facilities; the feed grain and wheat programs which involve direct payments to farmers; a commodity storage program; and, the Rural Environmental Assistance Program (REAP). All of these programs are administered at the county level by a local office staff headed by a three man committee of farmers elected by community committeemen who were elected by their neighbors. These county committees oversee the handling of millions of dollars of government funds each year. They make yield adjustments. They are also charged with the onerous job of deciding who to approve for REAP assistance. Under REAP the Federal Government shares the cost with farmers for doing certain approved conservation and pollution abatement work including animal waste management practices. A brief history of conservation work done on farms is given. (Cartmell-East Central).

### 1730 - A2, B2, D4 600

### SOIL CONSERVATION SERVICE PROGRAM IN ANIMAL WASTE MANAGEMENT

State Conservation Engineer, Soil Conservation Service, Des Moines, Iowa.
D. T. Bondurant.
Animal Waste Management Conference, Iowa State University, Ames, October 13-15, 1971, 6 p.

Descriptors: *Soil conservation, *Farm wastes, *Lagoons, *Anaerobic conditions, *Runoff, Storage tanks.
Identifiers: *Soil Conservation Service, *Animal wastes.

The feedlot registration program in Iowa went into effect on July 1, 1969, and in September, 1969, rules were adopted regulating feedlot runoff from cattle operations. The Soil Conservation Service believed that it could help with this program and, after consulting with the staff of the Iowa Water Pollution Control Commission, formulated a policy regarding activities in this work. Since then standards and specifications have been established for runoff control anaerobic lagoons and waste storage tanks. Any operatoar who feels that he has a potential pollution problem, even if his operation does not require registration, may be assisted, provided that he secures the approval of the plans developed for his runoff control facilities from the Iowa Pollution Control Commission. The policy of the Service in giving assistance on manure storage tanks is to furnish one of the available standard plans if it can be used directly or can be safely adapted. The Service will not design concrete storage tanks for individual installations. (Cartmell-East Central).

### 1731 - A5, B1, D3, E2 400

### MANURE DEODORANTS . . . HOW WELL DO THEY WORK?

Hog editor.
R. Wilmore.
Farm Journal, Vol. 96, p. 22, 38, June, 1972. 1 fig.

Descriptors: *Odor, *Farm wastes, *Livestock, *Costs, Lagoons.
Identifiers: *Manure, *Odor control, *Deodorants, Soil injection, Land disposal.

Dozens of products are now available which promise to control manure odors. The most comprehensive research has been run by Cornell University. A panel compared odors from treated samples with those from raw manure. Only three things are sure: no product eliminates all odors; some are more effective than others; some don't work at all. The problem of using products to control odor is the cost. The products are felt to be too expensive for what good they do. (Cameron-East Central).

### 1732 - B1 700

### PHOTOGRAPHIC STUDIES OF THE DUNGING BEHAVIOR OF PIGS IN CONFINEMENT

M. S. Thesis, Agricultural Engineering Department, Iowa State University, Ames, Iowa, 1971, 129 p. 31 fig, 38 tab, 33 ref.
J. P. Hultgren.

Descriptors: *Hogs, *Confinement pens, *Farm wastes, *Animal behavior, Economics, Temperature, Light, Design, Water pollution.
Identifiers: *Behavior patterns, Time lapse photography, Cleanliness, Air velocity.

The defecation behavior and feces placement of growing pigs was analyzed. Time lapse photography was used to study three groups of pigs subject to changes in three different environmental stimuli (air temperature, light levels, and air velocity placement). A summary of the results indicated that the pigs spent an average of 81.1% of the day sleeping, 7.6% standing, 10% eating, 0.9% drinking, and 0.4% defecating. Results indicated that the pigs establish quite logical activity patterns. It was also found that pigs defecate from 8-12 times per day. Other studies were concerned with the initial establishment of dunging areas in the pen and the effect of pen and pig cleanliness was found to be heavily dependent on area of pen per pig and area of pen slotted. Evidence was presented that time lapse photography is a useful technique in studying behavior and activity patterns. No matter what technique is used, however, swine defecation remains a very complex and perplexing behavior. (Russell-East Central).

### 1733 - B1, F1 , 300

### THE ECONOMICS OF THE CATTLE FEEDING INDUSTRY IN ARIZONA

Department of Agricultural Economics, Arizona University, Tuscon.
E. L. Menzie, W. J. Hanekemp, and G. W. Phillips.
Arizona Agricultural Experiment Station, Tucson, Technical Bulletin 207. October, 1973, 82 p. 36 fig, 57 tab, 35 ref.

Descriptors: *Feed lots, *Farm wastes, *Cattle, *Zoning, *Cost analysis, *Arizona, Marketing, Legal aspects, Water pollution sources, Environmental effects, Economics.

Major objectives were to determine changes in the growth and structure of the cattle feeding industry, costs of operation, costs of custom feeding, production problems affecting the competitive nature of the industry, and to analyze the nature of growth and development in beef markets. Data are based on 1972 information, and projections have been made to 1982. Considerable attention is paid to the Arizona feed situation, supply of feeder cattle for Arizona, controls affecting livestock feeding; sources, methods, and costs of finance for feedlots and feeding, marketing of fat cattle and beef, and an assesment of Arizona's competitive position in beef production and marketing, along with the role of changing technology in the industry. The section on controls includes a review of health and sanitation problems of Arizona feedlots, the control of feed supplements, and environmental issues. A particular case involving a suit brought by a land developer against a cattle feeding operation with a non-conforming prior usage right is described; the developer was required to pay for costs involved in the relocation of the feedlot. Consideration of the effect of feedlot wastes on water quality has given rise to a number of research investigations relating to recycling, conversion to other products, confinement feeding, etc., all of which should be accelerated because of the rising demand for beef at the same time that feedlot controls are creating limitations on this type of beef production. (Paylore-Arizona).

### 1734 - E3 700

### DIGESTIBILITY AND FEEDING VALUE OF WASTELAGE

L. S. Bandel.
M. S. Thesis, Department of Animal Science, Auburn University, 1969, 67 p. 3 fig, 18 tab, 52 ref.

Descriptors: *Feeds, *Digestion, *Waste disposal, *Recycling, Nutrient requirements, Farm wastes, Cattle, Lambs, Hogs, Poultry, Nitrogen, Protein, Carbohydrates, Chemical analysis, Feed lots, Performance, Diets.
Identifiers: *Wastelage, *Digestibility, Nylon bag test, Dry matter, Corn.

For the purpose of studying the feeding value of wastelage, six yearling steers were allotted to five groups of twelve animals each and were fed a variety of ratios of wastelage and ground or whole shelled corn. The first group was fed a normal steer fattening ration, while groups two through five were fed ratios of 1:4, 2:3, 2:3, and 3:2 of wastelage to corn. After a fourteen day adjustment period, the five groups of cattle were fed for 110 days. Results indicated that feeding wastelage and ground corn improved feed efficiency by eight percent. Also increasing the fiber content by increasing the amount of wastelage in the ration decreased digestibility. A nitrogen-balance test study was conducted with lambs, and it was found that the addition of wastelage to a ration usually lowered the crude protein and dry matter intake. Adding corn to wastelage usually improved the dry matter intake, crude protein digestibility, and the nitrogen retention. (Russell-East Central).

### 1735 - A5 700

### ODORS PRODUCED BY SWINE IN CONFINEMENT HOUSING

W. C. Hammond.
MS Thesis, Agricultural Engineering Department, University of Illinois, 1964, 83 p. 24 fig, 21 tab, 26 ref.

Descriptors: *Odor, *Hogs, Confinement pens, *Farm wastes, Analysis, Ammonia, Ventilation, Spectroscopy, Chromatography, Gases, Humidity, Temperature.
Identifiers: *Confinement housing, Concrete floor.

This project was undertaken to find out what makes confinement swine buildings have objectionable odor, where the odor originates, and some methods which reduce or destroy the odor. A comparison was made between buildings with solid concrete floors with a center gutter and totally slotted concrete floors with ponded waste under the whole floor area. The comparison of odors was made by an odor panel. Odor samples were collected and dilution thresholds ranged from 0.0 to 6.0. The 6.0 meant that no panel member could detect the odor present in the swine building when 6 parts of clean air were mixed with one part odor. The results of ammonia analyzed from the floor lead one to believe that the floor liberated a large part of the odor. This is a result of acid fermentation within the concrete. Statistical analysis fails to indicate any correlation between odor produced by swine in confinement buildings with respect to pig weight or floor temperature. The indication is that the swine odor is defined in terms of other variables such as humidity, dry bulb temperature, ventilation, or bacteria in the swine's atmosphere, or some other variable. (Russell-East Central).

### 1736 - A5, D4 700

### ODOR CONTROL AND DEGRADATION OF SWINE MANURE WITH MINIMUM AERATION

Department of Agricultural Engineering, Illinois University, Urbana-Champaign.
J. C. Converse.
PhD Thesis, Department of Agricultural Engineering, University of Illinois, Urbana-Champaign, 1970, 198 p. 58 fig, 48 tab, 36 ref.

Descriptors: *Odor, *Control, *Degradation (Decomposition), *Farm wastes, *Hogs, Confinement pens, Aeration, Gases, Anaerobic conditions, Ammonia, Hydrogen sulfide, Analysis, Chemical oxygen demand, Hydrogen ion concentration, Waste storage, Waste treatment.
Identifiers: *Swine, *Manure, Foaming.

Many problems are facing today's confinement swine production. One major problem is odor. Odor not only brings public indignance, it also is potentially harmful to swine enclosed in a confinement pen because of the gases which cause it. In total confinement, manure is often stored in pits for long periods of time. If good anaerobic decomposition occurs carbon dioxide and methane, which are odorless, will be given off. However, the condition which usually exists in an undisturbed pit is one in between good aerobic and anaerobic decompisition. As a result, $CO_2$, $H_2S$, $NH_3$, and $CH_4$ are emitted. Also many organic intermediates are found. Some of the intermediates are very odorous. Most researchers have concluded that an excessive amount of air is necessary for optimum manure degradation, but this results in high costs to maintain an excessive amount of air. However, the results of this study indicate that it is possible to aerate liquid hog manure with a small amount of air and still maintain relatively odorless conditions. What is necessary now is field applications to determine the feasibility of operating a system with minimum aeration. (Russell-East Central).

### 1737 - B1 600

### SLOTTED FLOORS FOR HOGS — PROGRESS AND TRENDS

Agricultural Experiment Station, Oregon State University, Corvallis.
A. J. Muehling.
Presented at 1971 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 7-10, Paper No. 71-930, p. 1-17. 26 fig, 1 tab, 13 ref.

Descriptors: *Hogs, *Farm wastes, *Design, *Construction, Materials.
Identifiers: *Slotted floors, Wood slats, Concrete slats, Metal slats.

Use of self-cleaning slotted floors for hog raising has made great changes in the industry. Labor costs for removal of manure have dropped, while sanitation and hog health have risen markedly. Three types of slats are used for flooring. Wood, usually hardwood laid green, is the cheapest, but does not last very long and warps easily. Because of the warping, it is difficult to maintain equal distance between the slats, a real problem when the pens are used for baby pigs. Concrete slats are very effective when they are well made, that is, when the reinforcing bar is laid on the bottom and when the tops are smoothed to eliminate abrasions on the animals' knees. The problem with concrete slats has been that commercially produced ones, of good quality, are hard to obtain, and transport costs are very high. The alternative is to cast them on the site, but not every farmer has produced slats of adequate quality when casting them himself. Metal slats are more expensive and may wear quickly if exposed to manure; this depends on the metal and on the amount of moisture present. The present trend is to all-slotted floors, rather than the partially slotted ones used a few years ago. They can be used, with adaptations, for all phases of hog-raising — farrowing, finishing, and sow gestation. Many sows will not breed on slats, however; perhaps it is too difficult to get a foothold. (Solid Waste Information Retrieval System).

1738 - B2, C5, E2 600

### STORAGE LAGOON VERSUS UNDERFLOOR TANK FOR DAIRY CATTLE MANURE

Agricultural Engineering Department
College of Agricultural and Life Sciences
University of Wisconsin
Madison
J. C. Converse, C. O. Cramer, H. J. Larsen, and R. F. Johannes.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-3028, 13 p. 5 fig. 4 tab, 6 ref.

Descriptors: *Waste storage, *Farm wastes, *Lagoons, *Cattle, *Dairy industry, *Costs, Confinement pens, Liquid wastes, Chemical characteristics.
Identifiers: *Manure, *Slotted floor-underfloor tank, *Manure scrape-storage lagoon

The following liquid manure handling systems were compared during a 2½ year study: slotted floor-underfloor tank, manure scraper-storage lagoon for insulated housing, and manure scraper storage lagoon for uninsulated housing.Each system handled 20 cows in free-stall housing. As was hoped the automatic manure scraper-storage lagoon provided a feasible alternative to storage of manure in tanks under slotted floors. For the size herds studied, investment costs for the manure scrape-storage lagoon system were approximately $200 cheaper per cow than for the slotted floor-underfloor tank. Annual costs for the manure handling system were approximately $20 cheaper per cow for the manure scrape insulated barn than for the other two systems. (Cartmell-East Central).

1739 - A1, A2, E2 300

### CATTLE FEEDLOT POLLUTION STUDY

Department of Agronomy
Texas Tech University
Lubbock
E. A. Coleman, W. Grub, R. C. Albin, G. F. Meenaghan, and D. M. Wells.
Interim Report No. 2 to Texas Water Quality Board, Texas Tech University Water Resources Center, Lubbock, Texas, April, 1971, WRC-71-2, 12 p. 8 tab.

Descriptors: *Waste treatment, *Waste disposal, *Cattle, *Feedlots, *Irrigation, *Runoff, Application rates, Soil contamination, *Farm wastes, Salts, Cotton, Grain sorghum, Soybeans, Bermudagrass.

Germination studies, test plot studies, and field studies were made to determine beneficial or non-harmful rates at which runoff from cattle feedlots can be applied to growing crops. Results indicate that such runoff must be applied with caution to most crops, as it is very detrimental to the germination of most field crops in the High Plains area of West Texas and is also detrimental to seedlings in the same area. However, relatively low application rates are beneficial to mature crops at least on a short term basis. The buildup of soluable salts in the upper 30 inches of the soil profile indicates that land disposal may not be the ultimate solution to runoff disposal. (Wetherill-East Central)

1740 - B1, E2 600

### RUNOFF CONTROL SYSTEMS FOR PAVED DAIRY CATTLE YARDS

Agricultural Engineering Department
College of Agricultural and Life Sciences
Wisconsin University, Madison
C. O. Cramer, T. J. Brevik, G. H. Tenpas and D. A. Schlough
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4016, 22 p. 11 fig. 6 tab.

Descriptors: *Runoff control, *Dairy industry, Precipitation (atmospheric), Effluent, Chemical properties.
Identifiers: *Paved cattle yards, *Solid separation, *Detention pond.

Runoff control systems were developed and monitored for two dairy cattle yards. One system was for 200 milk cows plus heifers in cold free stall barns with yard feeding. The other was for 32 cows in a stanchion barn with paved exercise yard for heifers and dairy beef in loose housing with yard feeding. Both systems used the same principles of solids separation, liquid storage and land application of wastes. At the first farm 49 and 45 percent of the precipitation falling on the paved and unpaved yards and contributing roof areas was collected as runoff for the two years of study. The corresponding volumes of effluent removed from the detention pond were 2.7 and 1.7 million gallons. At the second farm, the percentage of precipitation collected was 84, 67, and 71 percent for the three periods of study. The volume of effluent removed was 0.6 and 0.5 million gallons for the first two full years. Characteristics of the detention pond effluents varied widely. Rock-filled porous dams were unsatisfactory for primary liquids-solids separation. Expanded metal screens were better. Detention ponds in both systems had insufficient capacity to allow effluent to be applied only when soil conditions were favorable. Considerable labor and management were required for successful operation of the runoff control systems. (Merryman-East Central)

1741 - B1, D1, E2 400

### CHANGES WE'VE MADE IN MANURE HANDLING

Hoard's Dairyman, Vol. 118, No. 3, p. 152-153, 204-205, February 10, 1973. 4 fig.

Descriptors: *Farm wastes, *Waste storage, *Waste disposal, *Runoff, *Costs, Cattle, Dairy industry, Equipment.
Identifiers: *Manure.

Four dairymen with herds ranging from 30 to 230 cows discuss changes in their waste handling methods. All have switched to storage pits and then to land disposal at costs ranging from $850 to $6,000. Each farmer explains his variation of waste storage with respect to less frequent handling and controlling runoff. Costs, disposal practices and manure pits of each system are discussed. (Frantz-East Central).

1742 - A2, A5, B2, E2 700

### A COMPARISON OF AN AERATED LAGOON AND IRRIGATION SYSTEM WITH A CONVENTIONAL SYSTEM FOR DAIRY WASTE DISPOSAL

M. P. Douglas
MS Thesis, Department of Agricultural Engineering, Purdue University, 1971, 81 p. 24 fig. 23 tab, 27 ref.

Descriptors: *Lagoons, *Aerobic conditions, *Irrigation, *Waste disposal, *Dairy industry, *Farm wastes, Waste treatment, Waste storage, Costs, Odor, Runoff, Labor, Equipment, Construction, Indiana.

A comparison was made between the conventional waste handling system and an aerated lagoon and irrigation system at Purdue Dairy Center. The cost of the conventional system was $32.90 per cow per annum, but was largely dependent upon weather conditions. It showed high variable and labor costs. The newer method was a mechanically aerated deep lagoon, whose level was controlled by irrigation on adjacent land. Cost per cow was $48 per year, but much of the extra cost was reclaimed in greater flexibility of the farm operation and in labor utilization. Nitrate pollution in runoff into water was zero. The system was odorless while it was economically comparable to other systems. The influence of weather conditions and usage of labor were minimized. The new method was acceptable from the odor and pollution control aspect and would be acceptable to commercial enterprises. (Frantz-East Central).

1743 - B1, D4, E2 600

### STRUCTURAL ANALYSIS OF FLOOR GRIDS FOR CONFINEMENT CATTLE FEEDING SYSTEMS

North Dakota State University
Fargo
Presented at 1966 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 6-9, 1966, Paper No. 66-924, 21 p. 9 fig. 4 tab, 21 ref.

Descriptors: *Confinement pens, *Cattle, *Livestock, *Farm wastes, *Waste storage, *Waste treatment, *Waste disposal, *Design.
Identifiers: *Land disposal, *Storage pits, *Floor grids.

Perforated floor systems are being used in barns as devices for collecting waste material from livestock. Movement of the livestock on the floor forces the waste material through the perforations into storage pits below the floor. Livestock waste collected in this way can be spread on fields as fertilizer or can be stabilized by the action of microorganisms. These methods of livestock waste disposal are proving to be more efficient than conventional solid waste handling systems have been. Structural design, parameters, and equations are given. (Wetherill-East Central).

1744 - B1, D1, E3 600

### FIELD PERFORMANCE OF SELECTED BEEF FEEDLOT WASTE HANDLING SYSTEMS

Extension Agricultural Engineer
University of Illinois
Urbana-Champaign
D. H. Vanderholm, J. C. Lorimor, and S. W. Melvin.
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4015, 9 p. 5 fig. 2 tab, 2 ref.

Descriptors: *Cattle, *Farm wastes, *Management, *Feed lots, Monitoring, Waste storage, *Waste disposal, *Corn Belt, Oxidation lagoons.
Identifiers: *Pollution control.

Four feedlots were selected as research and demonstration sites to study waste management alternatives in the Corn Belt. Two were unsurfaced open lots utilizing holding ponds. The other two were cold confinement slotted-floor barns, one with a conventional deep pit manure storage and one with an under-floor oxidation ditch system. No attempt was made to rate the systems relative to one another, but data and observations were intended to provide a basis for evaluating the systems individually and collectively. All of the systems described in this paper were properly managed. (Cartmell-East Central).

1745 - A1, B1, E2 300

## GUIDELINES FOR APPLYING BEEF FEEDLOT MANURE TO FIELDS

Cooperative Extension Service
Kansas State University
Manhattan
Kansas State University
A publication of the Cooperative Extension Service, Kansas State University, Manhattan, 1974, 11 p. 9 fig, 4 tab, 7 ref.

Descriptors: *Feed lots, *Farm wastes, *Waste disposal, *Cattle, Nutrients, Nitrogen, Salinity.
Identifiers: Land application, *Guidelines.

This publication gives guidelines for applying solid beef-cattle, feedlot manure to agricultural land. Guidelines on solid manure given here can be used to determine (1) the amount of manure needed to supply enough nitrogen for crops, or (2) maximum rates when soil is used as a disposal medium for feedlot manure. These steps are suggested when applying beef cattle feedlot manure to soil: 1. Have the manure and irrigation water analyzed. 2. Determine the texture of the soil receiving the manure. 3. If the manure is to be a source of nitrogen, determine application rates for each year. 4. If the manure is applied to irrigated land, determine each maximum annual application rate. 5. If the manure is applied to non-irrigated land, determine the maximum annual application rate. 6. Have annual salt-alkali and soil fertility tests performed on the soil to check for salt buildup and nitrate accumulation. (Cartmell-East Central).

1746 - D1, E4 600

## CATTLE MANURE TO PIPELINE GAS — A PROCESS STUDY

Chemical Research Engineer
Pittsburgh Energy Research Center
Bureau of Mines
Pittsburgh, Pennsylvania
H. F. Feldman, K. Kiang, Chin Yung Wen, and P. M. Yavorsky.
American Society of Mechanical Engineers Publication, 73-Pet-21, 1973, 7 p. 1 fig. 3 tab, 6 ref.

Descriptors: *Farm wastes, *Cattle, *Gases, *Fuels, Pipelines, Costs, Waste treatment, Waste disposal.
Identifiers: Manure, Hydrogasification

A process study based on experimental manure hydrogasification data demonstrates the feasibility of converting manure to pipeline gas on a large scale. For reasonably large plants, the pipeline gas from such a conversion process is estimated to be considerably cheaper than gas from any other source, except natural gas currently being produced in the lower 48 states. The primary reason for these favorable economics is that the manure is assumed to be free. Because of the important effect of plant size on gas price, more detailed estimates will be made of smaller plants to determine the minimum feasibile plant size and thereby determine the areas of the country where application of this technology would be economically feasible. (Cartmell-East Central).

1747 - B1 100

## FLY PUPAE AS A DIETARY INGREDIENT FOR STARTING CHICKS

Department of Animal Sciences
Colorado State University
Fort Collins
J. S. Teotia and B. F. Miller
Poultry Science, Vol. 52, No. 5, p. 1830-1835, September, 1973. 6 tab., 6 ref.

Descriptors: *Diets, *Poultry, *Proteins, *Performance, Feeds.
Identifiers: *Fly pupae, Catabolized manure.

Since fly pupae have been demonstrated to have high quality protein, 2 feeding trials were conducted to determine their feeding value for broiler chicks. In the first trial, White Plymouth Rock broiler chicks were fed a standard chick starter ration and a diet containing 28% dried fly pupae as the only protein source. Chicks fed pupae as the only protein supplement showed no significant difference in weight gain when compared with chicks fed the control diet during the seven weeks of experimental period. In the second trial, fly pupae replaced fish meal and meat and bone meal. Catabolized manure was used from five to ten percent to replace milo in the ration. New Hampshire and Indian River broiler chicks were fed these rations from one day through four weeks of age. No significant differences in body weight or feed conversion were found among the different treatments. (Cartmell-East Central).

1748 - B1, D3, E3 600

## FLOCCULATING AGENTS FOR RECOVERING CATTLE WASTE SOLIDS

Agricultural Research Service
U. S. Department of Agriculture
Northern Regional Laboratory
Peoria, Illinois
R. W. Jones, J. H. Sloneker, and G. Frankl.
67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74 4037, 7 p. 7 tab, 9 ref.

Descriptors: *Flocculations, *Cattle, *Farm wastes, *Solid wastes, Proteins, Oxidation lagoons, Microorganisms, Settling, Nitrogen, Polymers.
Identifiers: *Flocculating agents, *Solids recovery, Manure.

A potential feed protein can be recovered from the solids of a cattle oxidation ditch. In some ditches, a viscous biopolymer interferes with settling and collecting suspended solids. A flocculating agent was found that increases recovery of suspended matter from 67 to 89 percent and of nitrogen from 45 to 82 percent. Expenditure of $1.00 for chemicals increases the quantity of feed fraction by an equivalent amount. A flocculating agent also raises the yield of feed from whole manure. Eight flocculating agents are listed. (Cartmell-East Central).

1749 - B1, C1, E1 600

## A CHARACTERIZATION OF THE EFFLUENT FROM COMMERCIAL CATFISH PONDS

Agricultural Enigneering Department
Purdue University
Lafayette, Indiana
D. B. Beasley and J. B. Allen
67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74 5004, 28 p. 16 fig, 5 tab, 9 ref.

Descriptors: *Effluent, *Fish farming, *Farm wastes, Water sampling, Ponds, Biochemical oxygen demand, Nutrients.
Identifiers: *Commercial catfish ponds, Total solids.

This investigation was carried out to obtain a meaningful chemical and biochemical characterization of the effluent from commercial catfish ponds. The water samples were taken from commercial catfish ponds in both the Mississippi and Arkansas Delta areas. The ponds ranged in size from 10 to 40 acres and the stocking rates included 1800, 2000, and 3000 fish per acre. All of the ponds were sampled on the surface, and one pond at each stocking rate was also sampled at the bottom. This data was arranged in order to compare both the differences in stocking rates and the difference in sampling depths. The water quality in the ponds monitored usually met or exceeded standards set forth for recreational waters by the Mississippi Air and Water Pollution Control Commission. In a majority of cases, the values of most of the parameters obtained from samples taken from the bottom of these ponds was slightly higher than corresponding values obtained from samples taken at the surface. Also, the ponds stocked at higher rates usually had slightly higher values of BOD, nutrients, and total solids. (Cartmell-East Central).

1750 - D3 100

## COMPARATIVE EFFECTIVENESS AND PERSISTANCE OF CERTAIN INSECTICIDES IN POULTRY DROPPINGS AGAINST LARVAE OF THE LITTLE HOUSE FLY

Department of Entomology and Plant Pathology
College of Agriculture
University of Massachusetts
J. W. Eversole, J. H. Lilly, and F. R. Shaw.
Journal of Economic Entomology, Vol. 58, No. 4, p. 704-709, August, 1965. 3 tab., 15 ref.

Descriptors: *Insecticides, *Poultry, *Farm wastes, *Waste treatment, *Larvae, *Toxicity, Massachusetts, Cultures.
Identifiers: *Little house fly, *fannia canicularis L.

Selected insecticides were added to poultry droppings and then compared. Each insecticide was added at five levels ranging from 0.25 mg/kg. of droppings to 4.0 mg./kg. Little house fly (fannia canicularis L.) larvae were added to the cultures at both 0 hr. and 48 hr. and placed in an incubator for seven days, Dimethoate was substantially more effective than the other insecticides. It produced substantial larval mortalities at the 0.25 mg./kg. level and remained effective after 48 hr. at the 1.0 mg/kg. level. Diazinon and coumaphos remained effective after 48 hr. at the 1.0 mg/kg. level. Other insecticides were less effective. (Frantz-East Central).

1751 - A1, C3, C5, E2 600

## CHEMICAL CHANGES IN SOLIDS USED FOR BEEF MANURE DISPOSAL

Department of Agricultural Engineering
Texas A & M University
College Station
D. L. Reddell, R. C. Egg, and V. L. Smith.
67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4060, 28 p. 13 fig, 5 tab, 22 ref.

Descriptors: *Farm wastes, *Cattle, *Waste disposal, *Sampling, *Soils, Rates of application, Nutrients, Nitrogen, Nitrates, Ammonia, Sodium, Chloride, Potassium, Texas.
Identifiers: Land disposal, *Pullman clay loam soil, Crop yields, Pollution.

To study the effects of large manure applications on land, research was started by the Texas Agricultural Experiment Station and the Texas Cattle Feeders Association. Manure was applied to Pullman loam soil in the High Plains of Texas at rates of 0, 224, 336, 672, 1345, and 2017 mtons/ha and deep plowed into the soil. A second manure application was made on the 0, 224, 336, and 672 mton/ha plots and a third application on the 0, 224, and 336 mton/ha plots. Soil samples were collected 17 months after the initial application. The sodium, chloride, potassium and conductivity of the samples increased greatly for the large manure application of 2017 mton/ha. Total nitrogen was greatly increased in the 0 to 30 cm soil layer. Crop yields for corn and grain sorghum were considered good for the 224, 336, and 672 mton/ha plots, but a 50 percent reduction. Crop yields occurred on the 1345 and 2017 mton/ha plots. The following conclusions were made: 1. Increased soil salinity problems caused by repeated large manure applications (1345 and 2017 mton/ha) will greatly decrease crop growth capabilities, 2. Annual manure applications of 224 to 336 mton/ha can probably be made for several years without decreasing crop yields substantially or causing serious environmental problems. (Cartmell-East Central).

1752 - A1, B3, D4, E3 600

### ANIMAL WASTES AERATION IMPROVES BIOREDUCTION BY FLY LARVAE

Entomology Research Division, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland.
N. O. Morgan and H. J. Eby.
Presented at Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-453, 9 p. 1 ref.

Descriptors: *Farm wastes, *Aeration, *Larvae, Poultry, Climate, Odor, Profit, Proteins, Salts, Ammonium salts, Carbonates.
Identifiers: Biological reduction, *Fly larvae, Manure.

An effective process for aerobic decomposition of livestock wastes and the production of useful byproducts was demonstrated by Calvert et. al. (1970). House fly larvae were selected as the bioreducing agent, Aeration of manure was the key condition to successful fly larval reduction of large volumes of manure in a minimum of space. When given the advantage of a controlled climate within a manure reduction cell, house fly larvae can convert 100 pounds of manure to 2.5-3.0 pounds of good protein feed supplement and 50-50 pounds of semidry, practically odorless soil conditioner. Although a dollar and cents value has not been calculated to include all of the products of the controlled wastes reduction program, the total recycling of livestock wastes could have quite a bearing on the stockman's economy. (Cemeron-East Central).

1753 - A2, A9 600

### BUFFALO LAKE RECREATIONAL WATER QUALITY: A STUDY IN BACTERIOLOGICAL DATA INTERPRETATION

Chief Bacteriologist, Water Supply Research Laboratory, National Environmental Research Center, United States Environmental Protection Agency, Cincinnati, Ohio.
E. E. Geldreich.
Water Research, Vol. 6, p. 913-924, 1972. 5 fig, 43 ref.
*Water quality, *Bacteria, *Water pollution, *Sewage effluents, *Feed lots, *Farm wastes, Coliforms, Texas.
*Buffalo Lake.

Descriptors: *Water quality, *Bacteria, *Water Pollution, *Sewage effluents, *Feed lots, *Farm wastes, Coliforms, Texas.
Identifiers: *Buffalo Lake,

Bacteriological measurements of fecal pollution, fecal coliform correlations with salmonella occurrence, and fecal streptococci significance in water are discussed. Buffalo Lake, some 30 miles southwest of Amarillo, Texas, is part of a national wildlife refuge managed by the U.S. Fish and Wildlife Service which permits various designated recreational uses including fishing, boating, water-skiing, swimming and camping. The major source of water entering Buffalo Lake is derived from Tierra Blanca Creek and its largest intermittent tributary, Frio Draw. The most significant pollution contribution during the dry weather occurs at a location where the sewage of Hereford, Texas, is processed through an Imhoff Tank into a trickling filter, and then passed into a series of 6 lagoons for further treatment prior to being discharged into the creek. Other pollution occurs from pasture and farmland drainage and from cattle feedlot runoff. Although this survey failed to demonstrate a significant public health hazard to recreational users of Buffalo Lake during the May to July, 1968, field study, a combination of factors necessary to produce unsatisfactory bathing water quality will continue to be a serious threat that could erupt in the future. Any sudden increase in fecal contamination of the bathing water will also introduce a concurrent rise in the probability that enterovirus, Salmonella, Leptospira, or other pathogenic strains will occur. Control measures are recommended. (Cartmell-East Central).

1754 - B1, D4 600

### BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF FOLLOWING SETTLING

Department of Civil Engineering
University of Nebraska
Lincoln
T. J. McGhee
Presented at the 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-413, 19 p. 12 fig, 1 tab, 13 ref.

Descriptors: *Feed lots, *Farm wastes, *Runoff, *Waste treatment, *Biological treatment, Activated sludge, Design, Costs, Chemical oxygen demand, Effluent.
Identifiers: Settling,

An activated sludge system designed for the treatment of settled feedlot runoff has been studied both in the laboratory and in the field. Initial studies utilizing the gravity solids return system demonstrated that reductions in COD of approximately 80% were attainable at liquid retention times of 4 days or more. From the data obtained in the laboratory study, it was concluded that the field system should be designed to operate at a liquid retention time of two days or more and at an organic loading rate of less than 1.0 lb. COD per lb. MLSS per day. Calculations based upon the average annual runoff from the lots and of the annual rates of precipitation and evaporation in eastern Nebraska indicated that the required volume would be 890 gallons assuming that operation would be possible for 180 days per year. The cost of effectively treating settled feedlot runoff with an aerobic biological system has been estimated to be $0.65 per head for the climatic conditions of eastern Nebraska. This cost is dependent upon animal density, climate, and the balance between holding pond and treatment unit size. (Cartmell-East Central).

1755 - A1, C1, E2 100

### AUTOMATED TOTAL NITROGEN ANALYSIS OF SOIL AND PLANT SAMPLES

Soil Scientist
United States Department of Agriculture
G. E. Schuman, M. A. Stanley, and D. Knudsen.
Soil Science Society of America Proceedings, Vol. 37, No, 3, p. 480-481, May-June, 1973. 2 fig, 2 tab, 6 ref.

Descriptors: *Sampling, *Soils, *Nitrogen, Digestion, Automation, Farm wastes, Fertilizers.
Identifiers: *Plants, Soil research.

Pollution-oriented research, dealing with commercial fertilization and animal wastes, necessitates analysis of large numbers of samples to characterize the problem. A digestion-analysis system that can digest large numbers of samples and analyze these digests at the rate of 30 samples per hour, is described, The tecator digestor and Technicon Auto Analyzer, has proved to be as reliable as the standard micro-Kjeldahl procedure and the system is compact and involves fewer steps for analytical error. (Cartmell-East Central).

1756 - A1, A2, B2, E2 600

### ANALYSIS OF RUNOFF FROM SOUTHERN GREAT PLAINS FEEDLOTS

Agricultural Research Service
United States Department of Agriculture
Bushland, Texas
R. N. Clark, A. D. Schneider, and B. A. Stewart.
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, June 23-26, 1974, Paper No. 74-4017, 11 p. 6 fig, 7 ref.

Descriptors: *Runoff, *Analysis, *Feed lots, *Rainfall-runoff relationships, *Farm wastes, Cattle, Plants, Irrigation, Salts, Waste dilution, Storm runoff, Great Plains,
Identifiers: Catchment basins.

Runoff amounts and chemical quality have been measured from a Southern Great Plains cattle feedlot. The rainfall-runoff relationship for runoff-producing storms was linear with about one-third of the rainfall in excess of 0.40 inch ending up as runoff. Two types of runoff catchment basins were used which met the zero discharge requirements of water control agencies. One was a natural-occurring, wet-weather lake called a playa. The other type was a manmade holding pond generally excavated downslope from the feedlot. High evaporation rates and high stocking rates caused the manure pack in the feedlots to contain more salts, thus allowing increased concentrations in runoff. For most holding ponds, a dilution ratio of 5 parts well water to 1 part feedlot runoff would reduce the salinity hazard for irrigation. Runoff caught in playas had enough natural dilution to be used with a minimum salinity hazard. (Cameron-East Central).

1757 - B2, D4, E2 600

### AN ANALYSIS OF THE WATER BUDGET AND WASTE TREATMENT AT A MODERN DAIRY

Agricultural and Biological Engineering Department
Mississippi State University
Mississippi State
J. B. Allen, J. F. Beatty, S. P. Crockett, and B. L, Arnold.
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4038, 28 p. 15 fig, 3 tab, 7 ref.

Descriptors: *Water, *Budgeting, *Analysis, *Waste treatment, *Farm wastes, *Dairy industry, Lagoons, Irrigation, Mississippi.

The objectives of this study were to investigate the water budget at a modern 130-cow dairy and to investigate the operating efficiency of a combined anaerobic-aerobic lagoon waste treatment system at the dairy. The water usage at a 114-cow dairy utilizing alley and milking parlor flush systems averaged 16, 738 gpd. The overall treatment efficiency of a 2 cell lagoon system receiving the dairy waste averaged 86.5%. The final effluent had an average BOD of 98 mg/1. Excess discharge from the lagoon system had an average BOD of 98 mg/1. Excess discharge from the lagoon system required disposal by irrigation on pastures during summer months. A reservoir with 15 acre-ft. of storage capacity will be required during winter months. (Cartmell-East Central).

1758 - B2, C5, D4, E2 300

### DESIGN PARAMETERS FOR ANIMAL WASTE TREATMENT SYSTEMS

Agricultural Waste Management Program
College of Agriculture and Life Sciences,
Cornell University
Ithaca, New York
T. B. S. Prakasam, R, C. Loehr, P. Y. Yang, T. W. Scott, and T. W. Bateman.
Environmental Protection Agency report number EPA-660/2-74-063, July, 1974, 218 p. 82 fig, 35 tab, 60 ref.

Descriptors: *Liquid aeration systems, *Farm wastes, *Oxidation lagoons, *Design, *Waste treatment, Nitrogen transformations, Nitrogen losses, COD removal, Odor control, Land disposal, Rates of application, Corn, Orchard and bromegrass response, Runoff losses.
Identifiers: Animal waste treatment, Design parameters, Plant response to treated and untreated poultry manure.

Laboratory, pilot plant, and full-scale studies evaluated design parameters for liquid aeration systems treating livestock waste. Of the various approaches tested, the mass balance approach is the preferred approach since it yielded results comparable to other approaches and involved fewer assumptions. Equations were developed to predict the COD and suspended solids concentrations in the effluent from the aeration systems. A design example is included for both odor control and stabilization of the waste including minimal aeration as well as nitrification. In laboratory and full-scale livestock waste treatment systems uncontrolled nitrogen losses occurred. Preliminary investigations identified the engineering opportunities for the control of nitrogen in aeration units by either conservation or removal. Acid soils conserved nitrogen in poultry manure, Neutral soils accumulated NO2 at toxic levels. Untreated manure was inferior to treated manure as a N source. Rates over 30 tons damaged corn. Runoff losses of N and P were slight. Orchard grass responded but bromegrass did not respond to poultry manure applications. (Prakasam, Scott — Cornell University).

1759 - A2, B1 300

### POLLUTION FROM ANIMAL FEEDLOTS

**Department of Agricultural Engineering**
**Kansas State University**
**Manhattan**
**R. I. Lipper.**
**Kansas Water Resources Research Institute, Manhattan, Project Completion Report, Contribution No. 121, May, 1973, 19 p. 17 fig, 15 tab, 28 ref.**

**Descriptors: Feedlots, *Water pollution sources, *Farm wastes, *Rainfall simulators, Runoff, Hydrology, Chemical oxygen demand, Biochemical oxygen demand, Nitrogen compounds, Bacteria, Solid wastes, Water pollution control.**
**Identifiers: *Beef animals, Characterization.**

Two test feedlots, each with an area of 0.05 were stocked with beef animals on a finishing ration at a rate of 200 animals per acre (10 steers per test lot). One feedlot was entirely surfaced with concrete, the other only at feedbunk and waterer. Slope was 2 percent. Rainfall was simulated by sprinklers capable of application rates from 0.4 to 2.5 per hour. Runoff was measured and sampled. Runoff rate and volume were compared to application rate and volume. Concentrations of BOD, COD, nitrogen compounds, solids, and bacteria were determined. The effects of certain management practices on runoff characteristics were observed. (Water Resources Scientific Information Center)

1760 - A5, B1, D1, E4 200

### HYDRAULIC HANDLING OF POULTRY MANURE INTEGRATED INTO AN ALGAL RECOVERY SYSTEM

**California University at Richmond and Berkeley**
**C. G. Golueke, and W. J. Oswald.**
**Presented at Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 57-58, 6 fig, 14 ref.**

**Descriptors: *Poultry, *Farm wastes, *Hydraulics, *Waste treatment, *Algae, Recycling, Settling tanks, Digestion tank, Feeds, Effluent, Aerobic conditions, Anaerobic conditions, Centrifugation.**
**Identifiers: *Manure, *Algae pond, Loading rates.**

Because of increasing pollution regulations and urbanization of rural areas, the problems of disposal of animal wastes are becoming more complex. Disposal by land spreading has in the past been the major means of disposal, but in many areas this method is no longer feasible. New and economically feasible methods of disposal are being developed and adopted. One such method is photosynthetic reclamation, with the incorporation of a manure hydraulic flushing and transport system. At the University of California's Sanitary Engineering Research Laboratory a three-year project is being conducted. Its objectives are to reduce the nuisance qualities of wastes and in the process, researchers are trying to recover algae which would be fed back to the animals. The project also involves the laboratory studies and design and construction of an algae growth pond. Plans for the future call for experiments in which the anaerobic phase will be by-passed. Also the algae which is harvested as a product of the wastes will be fed to ruminants to determine its nutrient potential. (Russell-East Central).

1761 - A2, C1 700

### HYDROLOGIC AND WATER QUALITY CHARACTERISTICS OF BEEF FEEDLOT RUNOFF

**W. J. Fields**
**M. S. Thesis, Department of Agricultural Engineering, Kansas State University, Manhattan, May, 1971, 79 p. 12 fig, 10 tab, 50 ref.**

**Descriptors: *Hydrologic properties, *Water quality, *Feed lots, *Cattle, *Runoff, Farm wastes, Lagoons, Waste storage.**

A study was conducted on a commercial cattle feedlot to determine runoff quantity and pollution parameters resulting from natural rainfall, to evaluate methods for predicting runoff quantity, rate, and pollution concentrations, and to develop and evaluate equations for estimating hydrologic and water quality characteristics of runoff from a beef feedlot. Two areas, No. 2 (25 pens covering 27.4 acres) and No. 119 (1 pen, 1.72 acres), were studied for runoff characteristics. Both areas drained into an anaerobic lagoon, Results indicated that mean pollutant concentrations from snowmelt runoff were 2 to 2.5 times greater than concentrations from rainfall runoff. Volatile solids percentages increased with decreasing temperatures. A chemical oxygen demand equation was determined for the runoff. A reliable basis for predicting feed lot runoff volume was developed. An equation for predicting maximum runoff flow rate was also developed. (Frantz-East Central).

1762 - A1, C1 700

### INVESTIGATION OF SOME FACTORS INFLUENCING DENITRIFICATION IN A LABORATORY SOIL COLUMN WITH A SURFACE LOADING OF LIVESTOCK WASTES

**C. V. Booram, Jr.**
**M. S. Thesis, Department of Agricultural Engineering, Kansas State University, Manhattan, May, 1971, 75 p. 22 fig, 14 tab, 27 ref.**

**Descriptors: *Denitrification, *Farm wastes, *Nitrates, Soils, Aerobic conditions, Anaerobic conditions, Equipment, Leaching, Kansas.**
**Identifiers: *Soil columns, *Surface loading.**

Two experiments were conducted to determine factors affecting denitrification in a laboratory loamy sand soil column. The first experiment was conducted under aerobic conditions for 17 weeks while the second was conducted under anaerobic conditions for 3 weeks. Water was added at a rate of 3.75 inches per week in both experiments, While the manure lost about 75% of its nitrogen concentration in experiment one, the soil gained. Approximately 79.6% of the nitrogen lost was due to leaching while the remainder was due to denitrification. Soil was sampled at 4 inch intervals and analyzed for pH, organic matter, ammonium nitrate, nitrate nitrogen, and total nitrogen. Water samples were analyzed for both COD and BOD. Gas analysis equipment problems prevented the successful elimination of atmospheric air in experiment two. It was hoped that replacing atmospheric air with 80% helium and 20% oxygen would enable the chromatograph to detect a change in nitrogen conecentration. (Frantz-East Central).

1763 - B3, D1, E2 600

### DRYING ANIMAL WASTES WITH SOLAR ENERGY AND EXHAUST VENTILATION AIR

**Agricultural Engineering Department**
**Purdue University**
**West Lafayette, Indiana**
**B. C. Horsfield**
**Presented at 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-411, 12 p. 14 fig, 22 ref.**

**Descriptors: *Drying, *Farm wastes, *Ventilation, Confinement pens, Waste treatment, Waste storage, Waste disposal, Computation, Indiana, Costs, Heat, Humidity, Temperature.**
**Identifiers: *Solar energy, *Computer study, *Solar dryer, *Animal wastes.**

A computer study was conducted to determine the technical feasibility of solar dehydration of farm wastes. The process involved the periodic removal of wastes from a slotted or partially-slotted floor, conveyance of waste into a continuously operating exhaust ventilation dryer, and conveyance and spreading of wastes into a solar dryer for ultimate drying and storage until the opportune time for spreading it on crop land. The solar dryer is essentially a large greenhouse with ample ventilation to prevent condensation. A computer simulation for three years of weather in central Indiana indicated that a solar dryer as large as the confinement unit can adequately dry the wastes under typical weather conditions. (Frantz-East Central).

1764 - A1, B1, D1, E1, F1 300

### DAIRY WASTE MANAGEMENT

**Charles L. Senn**
**City of Cerritos, California**
**C. L. Senn**
**Environmental Protection Agency Report (SW-58d), 1973, 152 p. 49 fig, 21 tab.**

**Descriptors: *Farm wastes, *Management, *Dairy industry, *Waste treatment, *Waste storage, *Waste disposal, Cattle, Water pollution, Odor, Recycling, Costs.**
**Identifiers: Composting, Flies.**

This report defines and evaluates the major environmental problems in managing solid wastes produced by high-density cow housing located in close proximity to residential developments. This study was conducted through a variety of approaches including public opinion surveys, environmental ranking systems, and actual on-site study of dairy farms. Evaluation is made of the various types of cow housing and solid waste management facilities, from the viewpoint of environmental and economic acceptability. Economic and environmental evaluations of the various systems for utilization or disposal of dairy wastes are also made. Methods and systems which will minimize fly production, odors, and drainage problems from earth corral dairies, especially in wet weather, must be developed. There is also a need for the development of a process to economically and efficiently compost manure on dairy farms. (Senn-Cerritos, California).

1765 - A6, B2, D1 400

### MANURE GASES KILL 25 HEAD IN OHIO

**A. Mackiewicz**
**Hoard's Dairyman, Vol. 119, No. 19, p. 1160, October 10, 1974, 1 fig.**

**Descriptors: *Gases, *Farm wastes, *Cattle, *Ohio, Ventilation, Waste storage, Dairy industry.**
**Identifiers: *Manure, *Slatted floor building, *Agitator.**

Twenty-four bred heifers and a bull were found dead in a slatted floor barn where they had been overcome by gas from a liquid manure pit. An agitator, used to break down solid manure into a slurry, created the gases in the air. The ventilation fans didn't pull out enough gases and the animals were killed. D. W. Bates, extension agricultural engineer, University of Minnesota, gave recommendations for agitation and pumping in slatted floor buildings. A high capacity ventilation system usually will exchange air in the building rapidly enough to keep gas concentrations below lethal levels, but the only completely safe way to protect animals from the toxic effect of gases is to turn them out of the building. (Cameron-East Central).

1766 - B2, D1 700

### WINTER PERFORMANCE AND THERMAL ENVIRONMENT OF SWINE IN A MODIFIED OPEN-FRONT HOUSE

D. D. Snethen
MS Thesis, Kansas State University, Manhattan, Department of Agricultural Engineering, 1971, 92p. 31 fig, 17 tab, 58 ref.

Descriptors: *Hogs, *Temperature, *Confinement pens, *Farm wastes, *Waste disposal, Heat transfer, Kansas, Oxidation, Instrumentation, Thermometers, Feeds, Thermal conductivity, Thermal insulation.
Identifiers: *Thermal environment, *Weight gains, Psychrometer, Thermocouple, Dry-bulb, Black-globe.

Previous studies of swine performance showed that the optimum air temperature for hogs varies from 61°F to 73°F depending upon hog weight. An open-front building was constructed in 1968. For the 1970-71 winter the open-front was covered with plywood and clear polyethylene. Propane burning radiant heaters were installed over the hogs' sleeping area. Comparisons were made between hog performance of the 1968-69 and 1969-70 winters and the 1970-71 winter. It was found that growing and finishing the hogs was successfully aided by the modifications. Daily weight gains were significantly improved over swine housed in an unmodified building. Ventilation requirements were reduced because moisture was condensed on the polyethylene film and ran out of the building. The modification also allowed a liquid manure oxidation pit to operate throughout the winter without impairment from freezing. (Frantz-East Central).

1767 - A4, B2, E2 300

### MANURE WASTE PONDING STUDY

California State Water Resources Control Board
D. Baier, J. L. Meyer, and D. R. Nielsen.
Contribution from the Cooperative Extension and the Agricultural Experiment Station of the University of California and the California State Water Resources Control Board, Sacramento, 14 p. 4 fig. 3 tab.

Descriptors: *Farm wastes, *Waste storage, *Waste disposal, *Groundwater pollution, *Nitrates, Leakage, Denitrification, Biochemical oxygen demand, Salts, Tensiometers, Poultry, Soils, Percolation.
Identifiers: *Holding ponds, *Manure.

Seventeen manure holding ponds were studied to determine rates at which the ponds sealed against leakage into underlying groundwater, rates of denitrification in the ponds and stratification of chemical constituents and BOD within the ponds. Additionally, the fate of nitrates and other salts were evaluated when field-dried manure was applied as fertilizer. Tensiometric techniques were used to determine hydraulic potential gradients and to obtain samples of the soil solution beneath the ponds. The solutions were analyzed for pH, total dissolved solids (TDS), and nitrates. In addition to the analyses of the solution, soil samples taken by auger just outside the edge of the ponds from the same depths were analyzed for nitrates and TDS, Even on coarse textured soils, ponds effectively sealed in 60 days or less. Almost no salt was lost from the ponds, but there was substantial denitrification. Applications of 40 yards of manure per acre resulted in higher nitrates in percolating leachates and slightly higher salinity than applications of 12 yards of manure per acre. (Cameron-East Central).

1768 - B1, E3 400

### IS TOTAL RECYCLING OF HEN MANURE POSSIBLE?

Poultry Digest, Vol. 32, No. 373, p. 130, March, 1973.

Descriptors: *Poultry, *Recycling, *Farm wastes, Fermentation, Digestion, Cellulose.,
Identifiers: *Manure, Polysaccharides, Hemicellulose., Microbial decomposition, Thermal decomposition.

Studies in the USDA's Agricultural Research Service laboratory and at Michigan State University point to methods for converting all manure from caged laying hens to feed for the hens. Caged hens are now fed a ration of 25% dehydrated poultry waste. Refeeding at a level of 30% would allow total recycling of the waste. An absence of fiber buildup in recycled hen manure suggests that either microbial or thermal decomposition occurs during recycling. Maximizing increases in microbial fermentation and in digestibility in the bird probably will permit refeeding at the 30% level, or total recycling. (Cameron-East Central).

1769 - B1, C5, D1, E3 400

### CONVERTING ANIMAL WASTES TO OIL

Area Resource Development Agent
Cooperative Extension Service
Pennsylvania State University
D. A. Harter,
Pennsylvania Township News, Vol. 27, No. 4, p. 26-27, April, 1974.

Descriptors: *Farm wastes, *Oil, *Fuels, *Waste treatment, *Waste disposal, *Recycling, Cellulose, Energy, Air pollution, Pressure, Sulfur, Economics, Pennsylvania.
Identifiers: *Pyrolysis, *Manure, Carbon monoxide.

Scientists at the Research Center in Pittsburgh have discovered that by a pyrolysis technique, manure can be converted to oil. The manure is placed in a reaction vessel with carbon monoxide at a pressure of 4000 p.s.i. and heated with little or no oxygen to 662-752°F for 15 minutes. Based on dry manure, the yield of oil is three barrels per ton. The oil produced has an energy content of 14,000 to 16,000 B.t.u. per pound compared to normal oil's B.t.u, value of 20,000. This source of energy is low in sulfur—an important property due to the need for low-sulfur oils to alleviate air pollution. Pyrolysis research on agricultural wastes has been strictly experimental to date. Due to the experimental nature of the work definite information on costs is now available. (Cameron-East Central).

1770 - B1, E2 400

### COSTS NOTED FOR SOLID AND LIQUID WASTE SYSTEM

Feedlot Management, Vol. 15, p. 58, January, 1973.

Descriptors: *Waste storage, *Waste disposal, *Liquid waste, *Farm wastes, *Costs, *Solid wastes, Settling basins, Lagoons, Irrigation, Legal aspects, Missouri.
Identifiers: *Manure, *Land disposal.

An animal waste disposal system was developed that meets Missouri law with respect to keeping waters of the state clean. Basically, the system involves returning waste solids and liquids to agricultural land and preventing them from getting into water resources. The liquids are drained off into a lagoon; the solids settle out in the settling basin. Solids are deposited on the land by using a conventional manure spreader. The liquids are spread through irrigation equipment. The annual costs to own and operate the system range from a low of 75c per head for a 400-head operation using the hand carry system to a high of $1.37 per head for a 1,200 head operation using the traveling gun system. (Cartmell-East Central).

1771 - E3 400

### DPW'S POULTRY FEED VALUE IS LIMITED

Manager, Meat Bird Research Division
Ralston Purina Company
St. Louis, Missouri
K. E. Rinehart
Poultry Digest, Vol. 33, No. 386, p. 158-159, April, 1974. 5 tab.

Descriptors: *Poultry, *Feeds, *Waste disposal, Amino acids, Calcium, Corn, Energy.
Identifiers: *Dehydrated poultry wastes (DPW), *Refeeding, Broilers, Hens, Excreta, Egg weight, Feed conversions, Purina Research Farm.

Studies indicated that the value of dehydrated poultry waste (DPW) as a feed ingredient for poultry and livestock is limited. Metabolizable energy determinations indicated DPW to have approximately 6% of the energy value of corn for hens; whereas, there was no energy volume in broilers and hens fed the DPW, indicating poor utilization. When rations were lowered to 80% of the amino acid level felt to be required, there was a numerical enhancement of production and egg weight. Feed conversions were depressed as level of DPW increased, suggestive of a lower energy worth than assigned. Extrusion of DPW fed in a ration with an excess of amino acids (110%) failed to enhance the energy value measured by feed consumption. It is concluded that DPW has no value for the young broiler with a value up to 6% of corn for hens. (Cameron-East Central).

1772 - B3, E3 400

### DRIED POULTRY MANURE NOT TOO EFFECTIVE IN LAYING HEN FEEDS

Arkansas University
P. W. Waldroup and K. R. Hazen
Arkansas Farm Research, Vol. 23, No. 3, p. 10, May-June, 1974. 1 tab.

Descriptors: *Poultry, *Farm wastes, *Feeds, *Diets, Waste disposal, Production, Mortality, Energy.
Identifiers: *Dried Poultry Waste (DPW), *Refeeding, *Laying hens.

Recently there have been a number of studies at laboratories regarding use of dehydrated poultry manure in poultry diets, especially in diets of laying hens. The following study was conducted to assess the value of this practice. Diets were formulated which contained 0, 5, 10, 15, 20, and 25% dehydrated poultry manure. The diets were fed for 112 days and records were kept on rate of production, feed consumption, egg size, and interior egg quality. Mortality during the trial was minimal and not influenced by dietary treatment. No significant differences were observed in egg size, but the interior albumen quality increased with the use of poultry waste. This can be attributed in large part to the reduction in rate of egg production. Daily feed intake increased as the amount of poultry waste in the diet increased. The energy content of the poultry manure is probably less than 400 M.E. kcal/lb. Because of this, it probably would not be a useful ingredient in diets in which high-energy feedstuffs are desired, (Cartmell-East Central).

1773 - B1, C5, D1, E1 100

### DAIRY CATTLE MANURE LIQUID: SOLID SEPARATION WITH A SCREW PRESS

J. R. Menear and L. W. Smith.
Journal of Animal Science, Vol. 36, No. 4, p. 788-791, April, 1973. 2 tab. 8 ref.

Descriptors: *Dairy industry, *Cattle, *Farm wastes, *Physical properties, *Chemical properties, *Waste disposal, Proteins, Nitrogen, Liquid, Organic matter.
Identifiers: *Screw press, *Press cake, Dry matter, Cell walls.

It is hoped that mechanical separation of the substances present in livestock manure may provide alternative and more economical methods for manure management and utilization. A continuously-fed screw press fractioned manure into two totally different fractions. The manure press cake was high in cell wall content (70.0%). The liquid was high in crude protein content (40.6%) on a dry basis. Actual description of the screw press, the fractionating experiments, and their results are discussed. (Merryman-East Central).

### 1774 - A9, B1 300

### EFFECT OF ATMOSPHERIC AMMONIA AND THE STRESS OF INFECTIOUS BRONCHITIS VACCINATION ON LEGHORN MALES

Department of Animal Sciences
Colorado State University
Fort Collins
H. F. Kling and C. L. Quarles
Supported by the Colorado State University Experiment Station and published as Scientific Series Paper 17 p. 2 fig. 4 tab. 14 ref.

Descriptors: *Poultry, *Ammonia, *Stress, *Farm wastes, *Pollutants.
Identifiers: *Leghorn males, *Infectious bronchitis vaccination.

Ammonia at levels of 0, 25 or 50 parts per million (p.p.m.) was introduced into 12 controlled-environment chambers containing male Leghorn chicks. Ammonia was introduced continuously into the test chambers from the 4th to 8th week of the experiment. An infectious bronchitis vaccination was administered to all chickens at 5 weeks of age. Body weights and feed efficiencies were determined at 4, 6 and 8 weeks of age. At 4, 5, 6 and 8 weeks of age lung and bursae of Fabricius weights, hematocrits and air sac scores were determined. Body weights and feed efficiencies were significantly reduced in the ammonia chambers. The bursae of Fabricius of the ammonia-stressed chickens were significantly larger than those of controls at 5 weeks of age and significantly smaller at 8 weeks of age. Chickens grown in ammoniated environments had significantly larger lungs at 8 weeks. Hematocrits were not significantly different among the treatments. Total air sac scores were significantly higher in the ammonia-stressed chickens at 8 weeks. Results indicated that chickens are affected by the stress of ammonia at levels of 25 or 50 p.p.m. and infectious bronchitis vaccination. (Kling and Quarles—Colorado State University).

### 1775 - A1, B1, E2 300

### ECONOMIC IMPLICATIONS OF WATER POLLUTION ABATEMENT IN FAMILY FARM LIVESTOCK PRODUCTION

Economics Division, Economic Research Service, United States Department of Agriculture, Urbana, Illinois, and East Lansing, Michigan, respectively.
R. N. Van Arsdall and J. B. Johnson.
United States Department of Agriculture, Economic Research Service report ERS-508, December, 1972, 44 p. 3 fig. 27 tab.

Descriptors: *Economics, *Water pollution control, *Farm wastes, *Management, *Livestock, *Legal aspects.
Identifiers: *Animal wastes, *Family operated farms.

A high-quality environment is important to farmers, but impediments to change exist: (1) Farmers and lenders are not certain of the performance of alternative methods of pollution control or the level of environmental quality that will eventually be required; (2) The market offers no economic incentive to change; (3) Diseconomies of size exist; (4) Age and tenancy make durable investments unattractive; and (5) Technical assistance is not yet available in the amount that will be required by new and pending legislation. State water pollution control statutes that apply to livestock production in the Northeast and North Central Regions are summarized. (Merryman-East Central)

### 1776 - A1, C1, D4, E1, F2, F4 300

### POLLUTION IMPLICATIONS OF ANIMAL WASTES. A FORWARD ORIENTED REVIEW

Kansas University
Department of Civil Engineering
Lawrence
R. C. Loehr
FWPCA Project, Kerr Water Research Center, Ada, Oklahoma, July 1968, 175 p. 12 fig, 4 tab, 141 ref.

Descriptors: *Cattle, *Hogs, *Poultry, *Farm wastes, *Waste disposal, Costs, Legal aspects, *Water treatment, Water pollution sources, Pollution abatement, Water pollution.
Identifiers: *Animal wastes.

The purpose of this review was to present a forward oriented state-of-the-art of pollutional implications which must be faced with the ever increasing trend toward confinement feeding large numbers of livestock. The manure wastes from all varieties of livestock under feed in the United States are characterized and related both to human population equivalents and beef cattle equivalents. The potential environmental hazards which may result from improper handling, storage, and disposal of these wastes were discussed. The effectiveness and economics of various conventional wastes treatment and disposal methods as related to confinement feeding wastes were evaluated. (Shuyler-EPA).

### 1777 - A1, B2, E2 200

### MOVEMENT AND TRANSFORMATION OF MANURIAL NITROGEN THROUGH SOILS AT LOW TEMPERATURES

Agricultural Engineering Department
Wisconsin University
Madison
M. F. Walter, G. D. Bubenzer, & J. C. Converse.
Sixth National Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, 26 p. 6 fig, 5 tab, 23 ref.

Descriptors: *Nitrogen, *Movement, *Soils, *Farm wastes, *Temperature, *Mathematical models, Livestock, Soil profiles, Ammonia, Evaporation, Liquid wastes, Dairy industry.
Identifiers: *Transformation.

Livestock waste has been implicated as a major source of environmental nitrogen pollution. An approach to the development of a quantitative mathematical model which predicts the concentration of nitrate in the soil solution based on empirical equations for the principal nitrogen transformations is described. This information is then combined with equations describing the movement of water and dispersion of nitrate through the soil profile. Parameters for equations to be used with the model were based on laboratory studies with Plainfield sand and heavy ammonium applications in the form of liquid dairy waste. The model was designed to quantitatively predict movement of relatively large quantities of nitrate in the soil solution, and it is particularly suited for heavy applications of ammonium because the early spring conditions for which it was developed occur for only a few months. The present model does not include plant uptake of nitrogen nor soil water movement due to evaporation. Therefore, the model is not applicable to systems with appreciable living vegetation nor can it be used in systems where evaporation has a significant effect on soil water movement. (Cartmell-East Central).

### 1778 - B1 400

### MODELS FOR HANDLING SOLID MANURE

Associate Swine Editor
B. Eltink and L. Searle
Successful Farming, Vol. 71, No. 11, p. 28-30, October, 1973.

Descriptors: *Solid wastes, *Farm wastes, *Management, Feed lots, Hogs, Cattle, Waste storage, Irrigation, Lagoons, Runoff, Costs, Capacity, Illinois,
Identifiers: *Manure, *Handling.

Solid waste handling systems are discussed. One waste system requires less than 50 hours per year handling manure from 2,500 hogs. It utilizes 100 feet lengths of perforated polyvinyl chloride plastic pipe for irrigation holding pond water. Costs, capacities and problems of irrigating, scraping, storing and stacking animal wastes are discussed. (Frantz-East Central).

### 1779 - A2, B1 700

### THE NITROGEN REGIME OF BEEF CATTLE FEEDLOT SOILS

Nebraska University
J. Boyce
PhD Thesis, Agricultural Engineering Department, University of Nebraska, 1970, 73 p. 21 fig, 5 tab, 22 ref.

Descriptors: *Nitrogen, *Feed lots, *Farm wastes, *Soils, *Cattle, Nitrates, Nitrites, Model studies, Anaerobic conditions, Aerobic conditions, Water pollution.

This study was carried out in model systems to determine the fate of applied nitrogen under simulated feedlot conditions and to examine the factors that influence the nitrogen regime of feedlot soils. The accumulation and form of nitrogen in soil materials incubated under simulated feedlot conditions were dependent upon the soil material, the rate of urea application, and the temperature-moisture regime of the incubations. The data indicated that the majority of the nitrogen added to feedlot soils is lost as NH3. Nitrates were found to persist in feedlot soils and manure in spite of anaerobic conditions. The rate of nitrogen loss from manure (feces and urea) was increased by the addition of 10 ppm N-Serve under aerobic conditions and by anaerobic conditions in the absence of N-Serve. It is suggested that feedlot soils can be managed in such a manner as to significantly increase the loss of N as NH3. Maximizing NH3 volitilization and maximizing the distance between feedlots and surface water may result in a minimizing of the detrimental environmental effects often associated with beef cattle feeding operations. (Cartmell-East Central)

### 1780 - A1, B1, D4, E2, F1 600

### THE PROBLEM OF FARM ANIMAL WASTE DISPOSAL

Department of Agricultural Engineering
Ohio State University, Columbus
E. P. Taiganides
Management of Farm Animal Wastes, Proceedings National Symposium on Animal Waste Management, American Society of Agricultural Engineers, Michigan State University, May 5-7, 1967, p. 5-8. 1 tab, 10 ref.

Descriptors: Farm wastes, *Waste disposal, *Livestock, *Poultry, *Confinement pens, Lagoons, Odor, Runoff, Water pollution, Costs.
Identifiers: *Animal wastes, Land application.

Animal wastes are one of the six sources of farm wastes whose management and disposal have become one of the most challenging problems of modern farming. The factors which cause and/or aggravate the animal waste disposal problem are: properties of animal wastes, current methods of livestock and poultry production, expansion of urban centers into rural areas plus public awareness of the need for healthy and aesthetically pleasant environment, and inadequacy of present methods of manure handling and disposal. On the basis of population equivalence data reported by Taiganides and Hazen (1966) the daily wastes from poultry, swine, and cattle alone are equivalent to 10 times the wastes of the human population of the United States. American animal producers seek waste disposal methods which have low labor requirements, reduce nuisance conditions, and improve sanitation. They are limited by lack of technical information and by the misconception that they should be able to dispose of manure at no extra cost. This lack of both the basic and applied knowledge necessary for successful handling, treatment, and disposal of farm wastes makes research in this area a unique challenge. (Marquard-East Central).

1781 - A2, B2 400

### THEY'RE GETTING THE JUMP ON POLLUTION CONTROLS

R. Graves and C. Hartman
Hoard's Dairyman, Vol. 119, No. 12, p. 468, June 25, 1974. 1 fig.

Descriptors: *Water pollution, *Control, *Confinement pens, *Farm wastes, *Runoff, *Diversion, Dairy industry, Waste storage, Livestock.
Identifiers: Manure, Environmental Protection Agency.

Farmers in Lafayette County, Wisconsin, are demonstrating that they will respond to positive, sensible programs aimed at controlling pollution and stream degradation from confinement livestock operations. With impetus provided by the county extension office and soil and water conservation district, many groups and agencies are involved in making the "Environmental Eye" a community project. The idea behind this project began in the spring of 1972. An environmental eye is both a real thing and a "gimmick." Looking at a hillside farmstead as an eyeball, a diversion up hill from the buildings forms an eyelash. A collection channel or diversion below the buildings completes the eye. These two diversions are important parts of any barnyard runoff control project. For most small yard situations, the diversion of water from above the barn prevents manure from being flushed or washed out of yards or storage areas. Rain falling directly on the yard will wash away little manure. This usually can be controlled by directing it away from streams or ditches to nearby pasture or cropland. If more control is necessary, a solids separation area, detention pond, or both, can be added at the end of the collection channel. (Cartmell-East Central)

1782 - B1, C1, F4 300

### POLLUTION ASPECTS OF CATFISH PRODUCTION — REVIEW AND PROJECTIONS

Agriculutural Engineering Department
Georgia University
Athens, Georgia
J. C. Barker, J. L. Chesness, and R. E, Smith.
Environmental Protection Technology Series Report EPA660/2-74-064, July, 1974, 121 p. 24 fig, 25 tab, 51 ref.

Descriptors: *Fish farming, *Catfishes, *Water pollution, *Organic wastes, Ponds, Effluent
Identifiers: Waste concentrations, Waste discharge, Biological organic removal, Raceways.

A literature review and field study was undertaken to determine the waste concentrations and discharge loadings occurring in the waters from catfish-culturing ponds and raceways. Water quality analyses were performed on samples taken during a 240-day growing season and at drawdown (assuming drainage at harvest). The natural biological degradation of the raw wastes in the ponds and raceway systems resulted in BOD reductions of 96.8% and 98.0% respectively when compared to waste levels produced in indoor single pass tank systems with no waste removal facilities. Reductions in total nitrogen of 97.2% and 97.7% occurred in ponds and raceways respectively, while ammonia nitrogen was reduced by 94.4% and 99.4% respectively. Sedimentation and biodegradation resulted in an 83.6% reduction in suspended solids in ponds and an 86.2% suspended solids reduction in raceways. Total phosphate levels were reduced by 98.5% and 97.4% in ponds and raceways respectively. (Chesness-Georgia University).

1783 - A1, E2 300

### QUALITY IMPROVEMENT OF FEEDLOT LAGOON WATER BY PERCOLATION THROUGH SOIL UNDER NATIVE PASTURE

Kansas Water Resources Research Institute
Manhattan.
W. L. Powers, L. S. Murphy, and B. R. Bock.
Contribution No. 131, January 1974, 50 p. 15 fig, 14 tab, 1 ref.

Descriptors: *Feedlots, *Percolation, *Soil chemical properties, *Water reuse, *Waste water treatment, *Bromegrass, *Phosphorus, Groundwater, Potassium, Absorption, Nitrogen.

Beef feedlot retained in catchment lagoons was applied as an irrigant for bromegrass to determine the effects of this practice on bromegrass yields, bromegrass N, P, K concentrations and uptake, selected soil chemical properties, and groundwater quality beneath the application area. Average applications of 9.3 and 19.0 cm of well water in one irrigation season produced no consistent differences. Lagoon water applications produced an accumulation of extractable K in the soil profile at the 0-to 30-cm depth for all treatments; largest accumulation was observed in the straight lagoon water treatment, an increase of from 470 to 588 ppm. Although approximately twice as much P was added in the lagoon water treatments as was removed by the bromegrass in one growing season, the average weak Bray extractable P for the 0-to 300-cm depth and for the 0-to 30-cm depth decreased for all treatments. After the first season of lagoon water applications, a moderate increase in the average water soluble C1- content of from 3 to 5 ppm was observed for the 0-to 300-cm depth. Analyses of groundwater samples from beneath the application area at depths of 7.6 and 21m revealed highly significant differences between these depths relative to concentrations of NO3--N, Ca, Mg, K, Na, C1-, and electrical conductivity values. Concentrations greater than 10 ppm for NO3--N in the shallow wells were common while the mean for all NO3--N values from the deep wells was 0.04 ppm. Mean values of 0.12 and 0.11 ppm were found for NH4+-N in the shallow and deep wells respectively. (Power-Kansas Water Resources Research Institute).

1784 - B2, F1 300

### THE WATER BUDGET AND WASTE TREATMENT AT A MODERN DAIRY

Water Resources Research Institute
Mississippi State University
State College
J. B. Allen, J. F. Beatty, S. P. Crockett, and B. L. Arnold
Completion Report, July 1973. 30 p. 15 fig, 3 tab, 7 ref.

Descriptors: *Dairy industry, *Hydrologic budget, *Waste treatment, *Mississippi, *Waste water treatment demand, lagoons, Industrial wastes, Biochemical oxygen demand.

This study was concerned with an analysis of the dairy water budget and an evaluation of the efficiency of a 2-cell lagoon waste treatment system for a modern 130-cow dairy at Holly Springs, Mississippi. The water budget at the dairy was determined by means of water meters installed on the main supply line, the alley flushing system, the milking parlor flush tanks, the prep stalls, the milk-room and the waterers. Data collection began on June 15, 1972, and continued through June 15, 1973. The water budget was summarized on a weekly basis by means of a computer print-out. For an average of 114 cows, the average water usage was 16,738 gallons per day (gpd). The amounts of water used in the various components of the dairy were: alley flushing systems, 5,372 gpd; milking parlor flush tanks, 6,869 gpd; prep stalls, 809 gpd; milk-room hot water, 320 gpd; cattle waterers, 2,113 gpd; and miscellaneous, 1,255 gpd. The BOD of the milking parlor wastes entering the first cell of the waste treatment system averaged 699 mg/1, and the BOD of the free stall alley wastes entering the first cell averaged 758 mg/1. The overall treatment efficiency of cell 1 (reduction in BOD) was 62.9%. The overall treatment efficiency of cell 1 plus cell 2 was 86.5%.

1785 - A1, D1, E1 300

### NITROGENOUS COMPOUNDS IN THE ENVIRONMENT

Environmental Protection Agency, Washington, D. C, Hazardous Materials Advisory Committee.
Environmental Protection Agency Report EPA-SAB-73-001, December, 1973, 187 p.

Descriptors: *Feed lots, *Waste water treatment, *Water pollution control, *Nitrogen compounds, *Farm wastes, Landfills, Ecology, Water pollution, Water pollution effects, Groundwater, Runoff, Urban areas, Sewage, Industrial wastes, Sanitary engineering, Air pollution, Nitrites, Fertiliers, Wastes, Food supply.
Identifierzs: Sanitary landfill leachate, Nitrosamines.

This report is a series of papers on the sources and methods of control and the environmental health effects of nitrogenous compounds. Diverse aspects of municipal and industrial sources are discussed—waterborne, atmospheric, agricultural, and industrial processes generating nitrogenous compounds. Attention is given to nitrogenous materials in waste and surface waters, efficiency of sewage treatment, effectiveness of the conventional BOD test, and the contribution of urban runoff and landfill leakage to the overall nitrogen load in the environment. Concentrations, sources, sinks, the transformation of nitrogenous materials in the lower atmosphere, control measures for stationary and mobile sources, retrofit systems for used cars, and new engine systems are reviewed. Plant nutrients, including fertilizers, and animal wastes are considered. The growing problems resulting from concentrated centralized livestock feedlots and methods of control are pointed out. Nitrogen is discussed as a nutrient essential to living organisms and as a toxicant within the aquatic environment. The carcinogenicity of nitrosamines and their precursors is described as a potential danger to health. Individual nitrogenous compounds are appropriately identified through the report. Analytical procedures for the identification and quantification of nitrogenous compounds are reviewed. Presented are the major concerns regarding nitrogenous compounds in the environment as these related to the following EPA activities: research, monitoring, and regulation. (Malone-EPA).

1786 - A1 300

### NATURE AND HISTORY OF THE NITRATE PROBLEM

Department of Veterinary Medicine and Surgery
School of Veterinary Medicine,
University of Missouri
Columbia
A. A. Case, G. Garner, G. E. Smith, and W. H. Pfander.
Science and Technology Guide, University of Missouri Extension Division, 1964, p. 9800-9801.

Descriptors: *Nitrates, *Nitrites, *Farm wastes, *Pollutants, *Water pollution, *Forages.
Identifiers: Methomoglonemia, Fuming silos, Animal wastes.

Excessive nitrate content of forage plants and "loaded" water supplies is being recognized in the corn belt states (Kansas, Iowa, and Missouri) as a serious problem. The major cause of these excessive nitrates seems to be animal wastes. Fuming silos are another source of nitrate poisoning. Fuming silos are grain storage silos which give off an often lethal gas during the filling and a week or so afterwards. This gas comes from forage that contains excessive amounts of nitrate or nitrite, but the amount doesn't have to be very high. Juice draining from fuming silos is also a dangerous toxic agent for anything exposed to it. Nitrate poisoning of human infants and of livestock is discussed. Symptoms are described. (Drewry-East Central).

1787 - A4, E2 300

### ESTABLISHING THE IMPACT OF AGRICULTURAL PRACTICES IN GROUNDWATER QUALITY

Department of Soil
Minnesota University
Minneapolis
R. G. Gast and P. R. Goodrich.
Paper No. 1549 Miscellaneous Journal Series, Minnesota Agricultural Experiment Station, University of Minnesota, p. 79-91. 1 fig. 4 tab. 9 ref.

Descriptors: *Water pollution sources, *Groundwater, *Farm wastes, *Fertilizers, Nitrogen, Water quality, Nitrates, Water pollution.
Identifiers: Groundwater pollution.

Agricultural croplands constitute about 35% of the total land area of the state of Minnesota and consequently overlay extensive groundwater reserves. Agricultural practices on these lands often involve application of large quantities of herbicides, pesticides, and nitrogen, phosphorus and potassium in fertilizers and animal wastes which pose potential threats to groundwater quality. All of these materials except nitrogen are strongly absorbed by the soil and pose little threat to groundwaters. Nitrogen (as nitrate) is mobile and will move into groundwater if allowed to accumulate in the soil. Optimum crop yields can be sustained without nitrate accumulations in the soil if proper fertilization rates are used. If animal wastes are concentrated in a small area, they move almost directly into the groundwater by such mechanisms as sinkholes and defective well casings or by saturated flow through soils. Contamination of groundwaters from such sources can be minimized by locating larger operations consistent with proper soil and hydrologic conditions. (Knapp-USGS)

1788 - A2, C1 100

### MICROBIAL POPULATION OF FEEDLOT WASTE AND ASSOCIATED SITES

Agricultural Research Service
Peoria, Illinois
R. A. Rhodes and G. R. Hrubant
Applied Microbiology, Vol. 24, No. 3, p. 369-377, September, 1972. 4 fig. 1 tab. 14 ref.

Descriptors: *Farm wastes, *Feed lots, *Cattle, *Runoff, *Pollutant identification, *Microorganisms, Confinement pens, Coliforms, Anaerobic bacteria, Yeasts, Fungi, Water pollution sources, Sampling, Methodology, Bacteria, Isolation, Soil disposal fields, Domestic animals, Ruminants, Analytical techniques.
Identifiers: Sample preparation, Culture media, Streptomycetes, Enumeration.

A quantitative determination was made every 2 months for a year of the microflora of beef cattle waste and runoff at a medium-sized midwestern feedlot. Counts were obtained for selected groups of organisms in waste taken from paved areas of pens cleaned daily and, therefore, reflect the flora of raw waste. Overall, in terms of viable count per gram dry weight, the feedlot waste contained 10 billion total organisms, one billion anaerobes, 100,000,000 gram-negative bacteria, 10,000,000 coliforms, 1,000,000 sporeformers, and 100,000 yeasts, fungi, and streptomycetes. The specific numbers and pattern of these groups of organisms varied only slightly during the study in spite of a wide variation in weather. Data indicate that little microbial growth occurs in the waste as it exists in the feedlot. Runoff from the pens contained the same general population pattern but with greater variation attributable to volume of liquid. Comparable determinations of an associated field disposal area (before and after cropping), stockpiled waste, and elevated dirt areas in the pens indicate that fungi, and especially streptomycetes, are the aerobic organisms most associated with final stabilization of the waste. Yeasts, which are the dominant type of organism in the ensiled corn fed the cattle, do not occur in large numbers in the animal waste. Large ditches receiving runoff and subsurface water from the fields have a population similar to the runoff but with fewer coliforms. (Holoman-Battelle).

1789 - A5, C1 200

### SWINE FECAL ODOR AS AFFECTED BY FEED ADDITIVES

S. H. Ingram, R. C. Albin, C. D. Jones, A. M. Lennon, L. F. Tribble, et al.
Texas Tech Laboratory
Lubbock
Presented at the Annual Meeting, American Society of Animal Science, Southern Section, Atlanta, Georgia, February 4-7, 1973, 5 p. 6 tab.

Descriptors: *Hogs, *Farm wastes, *Odor, *Feeds, *Additives, Sampling, Diet, Volatility, Yeasts, Texas Chromatography, Air pollution.
Identifiers: *Swine, Skatole, Indole, Lactobacillus acidophilus.

A grain-soybean meal diet was fed to 4-week-old hogs. Fecal samples were evaluated by olfactory panels. Reduction in volatile matter was scaled by using comparisons between the basal diet and dietary treatments. A lyophilyzed yeast culture and a commercial preparation of Lactobacillus acidophilus reduced the skatole and indole content of the feces, but changes in volatile matter were not detected. (Frantz-East Central).

1790 - B3 100

### A FAECES COLLECTOR SUITABLE FOR MALE CALVES

Immunology Unit, Department of Veterinary Surgery,
Royal (Dick) School of Veterinary Studies
Summerhall, Edinburgh
E. F. Logan, and D. J. Ormrod.
The Veterinary Record, Vol. 93, No. 4, p. 104-105, July 28, 1973. 2 fig. 4 ref.

Descriptors: *Farm wastes, *Cattle, Adhesives.
Identifiers: *Faeces collector, *Male calves.

Using latex rubber adhesive, Logan and Ormrod designed a faeces collector suitable for male calves. A cast was made out of the hindquarters of a new-born Ayrshire calf. Using plastic and glass containers which were held in position by plaster of paris bandage, the cast was built up into a conical shape. The mould was covered with layers of rubber latex adhesive and surgical gauze to a thickness of 1/8". Webbing straps with buckles were fixed to the collector by contact adhesive—two dorsally, two ventrally and two latterally. To the end of the latex cone a long, 5 in. wide nylon sleeve was attached. The collector was fitted over the calf's rump and fastened by the straps to a webbing body belt, which was fixed to a collar around the calf's neck to prevent the body belt slipping backwards. The collector has proved to be effective, very durable and easily cleaned. The use of latex rubber and gauze gives the collector elasticity, allowing faeces to be efficiently channelled into the nylon sleeve even when calves are recumbent. (Cameron-East Central).

1791 - A1, B2, C1, C5, E2 700

### PROCESSED ANIMAL WASTE EFFLUENT DISPOSAL IN SOIL BY A PRESSURIZED SUBSURFACE SYSTEM

F. S. Chuang
PhD Thesis, University of Massachusetts, Amherst, June, 1971, 155 p. 51 fig. 22 tab. 70 ref.

Descriptors: *Farm wastes, *Effluent, *Waste disposal, *Soils, Pollutants, Sewage, Irrigation, Chemical characteristics, Physical characteristics.
Identifiers: *Animal wastes, *Subsurface disposal system.

This study was undertaken to determine reliable subsurface waste disposal procedures and to study the effects of flow through the soil of processed animal waste effluent on the quality of percolate water and soil environment systems. The experiments were statistically designed for two treatments of soil bulk density and four treatments of flow with three replications. In order to show the reliability of the comparisons for (1) the degree of tertiary treatment by the soil, (2) chemical and microorganism characteristic changes in the soil, and (3) the results of flow rate, two confidence levels (90% and 95%) were selected. Data revealed that once-a-week dosing was an efficient treatment when used in a subsurface disposal system. It was concluded that the waste stabilization system utilized provided a final effluent which was suitable for this system of disposal. (Russell-East Central).

1792 - A2, B2, E2 300

### SOME PHYSICAL AND ECONOMIC ASPECTS OF WATER POLLUTION CONTROL FOR CATTLE FEEDLOT RUNOFF

Texas Tech University
Lubbock
T. R. Owens, D. Wells, W. Grub, R. C. Albin, and E. Coleman.
Unpublished Paper, Texas Tech University, Lubbock, 20 p. 9 tab.

Descriptors: *Water pollution, *Control, *Runoff, *Farm wastes, *Feed lots, *Cattle, *Economics, *Waste treatment, *Waste storage, *Waste disposal, Costs, Texas, Chemical properties, Irrigation, Basins, Model studies, Rainfall, Evaporation, Performance.
Identifiers: Land disposal, Slotted floors, Manure, Playa lake disposal.

Quantitative and qualitative aspects of feedlot runoff are studied. Average concentrations of pollutants in feedlot runoff are determined. Collection basin designs were discussed as runoff control measures. Comparative operating and investment costs are approximated with limitations discussed. Open land disposal has been attempted but modified environmental feeding on slotted floors is recommended as an approach to the problem. Pros and cons of the latter are discussed. (Wetherill-East Central).

1793 - A2 100

### DISPERSION DURING FLOW IN POROUS MEDIA WITH BILINEAR ADSORPTION

School of Chemical Engineering
Purdue University
West Lafayette, Indiana
S. P. Gupta and R. A. Greenkorn
Water Resources Research, Vol. 9, No. 5, p. 1357-1368, October, 1973. 4 fig. 27 ref.

Descriptors: *Dispersion, *Flow, *Porous media, *Bilinear adsorption, *Groundwater pollution, *Measurement, Feed lots, Runoff, Farm wastes, Fertilizers, Pesticides, Herbicides, Cultivated lands, Domestic wastes, Industrial wastes.

Major sources of the pollution in underground water are various compounds that may come from the runoff of cattle feedlots, from the runoff of fertilizers, pesticides, and herbicides from the cultivated lands, and from domestic and industrial wastes. In this paper the solution is presented for a bilinear rate of adsorption. This adsorption mechanism was proposed for ion exchange and adsorption columns. The mechanism is appropriate for adsorption in soils and columns of soil. Morever the solution can easily be modified for a first-or second-order rate of adsorption. The equations for the movement of chemicals in porous media with dispersion and adsorption using a bilinear rate of adsorption may be solved by the Crank-Nicolson method for homogeneous porous media. The solution for a field model 100 feet long is reported to 2 pore volumes; 31.0% of the solute is being adsorbed, and the system will require 36.5 pore volumes at saturation. (Cartmell-East Central)

1794 - A1, B2, D4, E2 300

### LIQUID MANURE MANAGEMENT FOR SWINE OPERATIONS

Texas Agricultural Extension Service
Texas A&M University System
College Station
B. R. Stewart and J. M. Sweeten
Report MP-1128, Texas Agricultural Extension Service, Texas A&M University, College Station, 8 p., April, 1974. 5 fig, 4 tab.

Descriptors:: *Liquid wastes, *Management, Aerobic lagoons, Irrigation, Design.
Identifiers: *Swine, Storage pits, Anaerobic lagoons, Land disposal, Application rates, Tank wagons, Soil injection.

Swine waste management involves the control of runoff from open lots and management of manure and waste water from confinement systems. The objective of manure handling should be to collect, transport and dispose of waste on land in an efficient and odor-free manner. Two basic approaches to manure handling are solid and liquid handling. Liquid manure handling systems can be characterized according to the methods of collection, storage, treatment and disposal. Liquid manure management systems involve substitution of water and mechanical equipment for labor and bedding. This results in quick separation of the animal from its wastes, improved general sanitation and reduced opportunities for disease transmission. Lagoons provide a means of biological treatment and storage of liquid manure from confinement swine buildings. Regardless of the manure handling or treatment system employed, raw or treated waste should ultimately be disposed of on pasture or crop land in a manner that will reuse nutrients and prevent pollution of surface and ground water. (Cameron-East Central).

1795 - A1, B2, D4, E3 200

### HARVESTING NUTRIENTS FROM SWINE WASTES

Department of Animal Science
University of Illinois
B. G. Harmon.
Proceedings of 23rd Annual Minnesota Nutritions Conference, 1972, 8 p. 10 tab, 16 ref.

Descriptors: *Nutrients, *Hogs, *Farm wastes, *Waste treatment, Oxidation lagoons, Confinement pens, Odor, Aerobic treatment.
Identifiers: Oxidation ditch mixed liquor (ODML)

The magnitude of swine excreta production in large confinement operations presents the potential for liquid, solid and gaseous pollution. Aerobic treatment of the excreta with a system like an oxidation ditch minimizes the opportunity for odor problems. The nutritive value of fresh excreta is enhanced by the oxidation ditch's aerobic microbiota which digest the excreta and assemble single cell protein. It has been found that adding oxidation ditch mixed liquid to a diet marginal in amino acids improves the performance of finishing swine. Utilization of this liquid product provides a source of water and nutrients for swine, while minimizing any chance of liquid or solid pollution. (Cartmell-East Central).

1796 - A1, B1, B3 100

### SLUDGE DISPOSAL: A CASE OF ALTERNATIVES

Water Pollution Control Federation Manforce. Deeds and Data, December, 1971, p. D-1—D-4.

Descriptors: *Sludge disposal, *Waste treatment, *Waste disposal, Fertilizers, Irrigation, Soils, Incineration, Lagoons.
Identifiers: *Alternatives, Land disposal, Ocean disposal.

A panel discussed alternatives for sludge disposal. Some treatment plants can transport sludge to crop lands. Guidelines can be written for heated anaerobically digested sludge to be applied at rates up to 100 dry tons/acres for any soil type. Cadmium, lead, mercury, copper and chromium in the sludge do not appear to be detrimental to crops. There are also extremely few pathogen problems. Cities like New York, however, don't have available land to dispose of effluent. Other disposal methods are incineration, ocean disposal, and lagooning. Very little survey work cost data has been published on various methods of sludge disposal. It is obvious that much more experimentation and research is needed in order to solve the sludge disposal problem. (Wetherill-East Central)

1797 - B3, D4, E3 400

### WASTE PROCESSING PLANT IS PLANNED AT UNITED BEEF

Beef, Vol. 11, No. 2, p. 13, October, 1974.

Descriptors: *Farm wastes, *Waste disposal, *Cattle, *Feeds, Feed lots, Fertilizers.
Identifiers: Waste processing, Aerobic digestion, United Beef Producers.

The Searle Agriculture, Inc, has started construction of an animal waste processing plant on the United Beef Producers feedlot. The process, aerobic digestion, results in a product that has use as a soil conditioner, potting soil base, or possibly a base for a nitrogen fortified fertilizer. It also has the potential as a feed ingredient for cattle. Samuel Huttenbauer, Jr., President of U.B.P., stated the plant will give a means of waste disposal to improve the sanitation program and an opportunity to participate in developing a feed ingredient for cattle feeding industry. (Cameron-East Central).

1798 - A1, A5, B2, C5, D4, E1 100

### EVALUATION OF ANAEROBIC LAGOON TREATING SWINE WASTES

Sanitary Engineering Department
Mississippi State University
State College
A. Shindala and J. H. Scarbrough
Transactions of the ASAE, p. 1150-1152, 1972. 4 fig, 2 tab, 3 ref.

Descriptors: *Lagoons, *Anaerobic conditions, *Waste treatment, *Farm wastes, *Hogs, Odor, Waste disposal, Water pollution,

The effectiveness of a single cell anaerobic lagoon in the treatment of swine wastes was investigated. Compiled data revealed that anaerobic lagoons would provide considerable reduction in the pollutional characteristics of animal wastes. The effluent, however, was still offensive and required further treatment prior to discharge. (Marquard-East Central).

1799 - A1, B1, E1, F2 400

### FARM POLLUTION: HOW REGULATIONS AFFECT YOU

Successful Farming, Vol. 72, No. 8, p. 30; June-July, 1974.

Descriptors: *Permits, *Regulation, *Livestock, *Farm wastes, Waste storage, Waste disposal, Cost sharing.
Identifiers: *Laws, Farm pollution.

Several states now administer Federal discharge permits. Only one permit is needed which covers both state and Federal regulations. But in most states, you need two permits—both state and Federal. All livestock facilities, which have a waste discharge and which hold for 30 days the following number of animals, must apply for a permit: slaughter and feeder cattle—1,000; mature dairy cattle—700; all swine over 55 lbs.—2,500. Livestock confinement facilities include open feedlots, confined feeding operations, stockyards, livestock auction barns and buying stations. Non-point source regulations are gaining consideration. Information and instructions on how to apply for permits and where to get cost-sharing help is given. (Cameron-East Central).

1800 - A1, E2 100

### EFFECTS OF CONTINUOUS (ZEA MAYS L.), MANURING, AND NITROGEN FERTILIZATION ON YIELD AND PROTEIN CONTENT OF THE GRAIN AND ON THE SOIL NITROGEN CONTENT

Department of Agronomy
Nebraska University
Lincoln
F. N. Anderson and G. A. Peterson
Agronomy Journal, Vol. 65, No. 5, p. 697-700, September-October, 1973. 4 fig, 4 tab, 9 ref.

Descriptors: *Corn, *Nitrogen, *Fertilizers, *Proteins, *Soils, Nitrogen depletion
Identifiers: *Manuring, *Yield

The specific objective of this paper was to report the cumulative effects of 60 years of continuous corn on yield and protein content of the grain and the nitrogen supplying capacity of the soil. It was concluded from the data that manuring is a valuable practice in maintaining soil productivity. It was shown that nitrogen fertilization alone was capable of restoring most of the production capacity of the soil. Initiation of nitrogen fertilization resulted in a much more rapid recovery of yield than did the initiation of manuring. Protein levels in the corn grain were consistently highest on manured treatments at all but the 180 kg/ha nitrogen fertilizer rate. Cultivation without manuring or nitrogen fertilization decreased the soil nitrogen content forty percent after 30 years of continuous corn production. Manuring from 1941 to 1972 increased the total soil content to 90 percent of the level present in the soil in its native condition. (Cartmell-East Central).

1801 - A5, B3, D4 100

### ENVIRONMENTAL CONDITIONS AFFECTING DEVELOPMENT OF HOUSE FLY LARVAE IN POULTRY MANURE

Department of Avian Science
Colorado State University
Fort Collins
J. S. Teotia and B. F. Miller.
Environmental Entomology, Vol. 2, No. 3, p. 329-333, June, 1973. 3 fig, 7 tab, 4 ref.

Descriptors: *Farm wastes, *Poultry, *Larvae, *Biodegradation, Temperature, Moisture content, Odor.
Identifiers: *Development, *Manure, *House fly larvae, Pupae.

The studies reported here were to determine the optimum conditions for house fly larvae to biodegrade poultry manure. Fly eggs were collected, separated from manure, weighed and inoculated in the fresh poultry manure in plastic tubs (14 x 12 x 5-inch deep) daily. Inoculation rates varied frim 2 to 5 g of eggs per 4 kg of poultry manure. These tubs were stored at different temperatures (22 degrees-38 degrees Centigrade) and RH conditions (19-80 percent) in a modified chick incubator. Optimum yield of dry pupae (weight) was obtained with a combination of 3 g of fly eggs in 4 kg of fresh manure at 27 degrees Centigrade and 41 percent RH. As the quantity of fly eggs per gram of poultry manure was increased, the yield of pupae was depressed. The environmental humidity had a profound effect on the yield of pupae. When the RH of the digestion chamber was increased from 38 to 70 percent the yield of pupae at temperatures of 34 degrees—38 degrees Centigrade was increased significantly. Approximately 8 days were required for the fly eggs to be converted to pupae in the fresh poultry manure at 27 degrees Centigrade and 41 percent RH. Fly eggs can be used to digest the manure under caged birds. The odor of digested manure is reduced. The moisture content of the digested manure varied from 50.0 to 67.5 percent, whereas the moisture content of undigested manure was 80 percent. (Cartmell-East Central)

1802 - A1, B2, C5, D4, E2, F1 300

### ENVIRONMENTAL, ECONOMIC, AND PHYSICAL CONSIDERATIONS IN LIQUID HANDLING OF DAIRY CATTLE MANURE

G. L. Casler and E. L. LaDue
New York's Food and Life Sciences Bulletin (Social Sciences: Agricultural Economics, No. 1), No. 20, 23 p. October, 1972. 10 tab. 42 ref.

Descriptors: *Dairy industry, *Cattle, *Farm wastes, *Waste storage, *Waste treatment, Waste disposal, *Liquid wastes, Odor, Runoff, Economics, Nutrients, Costs, Storage tanks, Oxidation lagoons.
Identifiers: Land spreading, Slatted floors, Open pits.

The environmental, economic, and physical implications of liquid manure handling for dairy cattle is considered. It was found that six months storage of liquid manure for disposal in the spring is not always beneficial. Large quantities of manure spread in the spring just before heavy rain may cause more stream pollution than small quantities spread daily during the winter. Also, odor is more offensive in the spring. An investment of $27,000-$37,000 would be required for a 100-cow liquid manure system with a six month storage capacity. Labor savings and increased manure value offset only a small part of the annual costs of a liquid manure system. The total return to the farm operator will rarely offset the costs incurred. Even if all costs and benefits could be internalized to the farm level costs would usually exceed benefits. (Ballard-East Central).

1803 - B3, E3 600

### FEEDLOT ANIMAL WASTE COMPARED WITH COTTONSEED MEAL AS A SUPPLEMENT FOR PREGNANT RANGE COWS

Agricultural Engineering Department
California University
Davis
J. L. Hull and J. B. Dobie
Presented at 1973 Winter Meeting, American Society of Agricultural Engineering, Chicago, Illinois, December 11-14, 1973, Paper No. 73-4506, 12 p. 3 fig. 2 tab. 8 ref.

Descriptors: *Farm wastes, *Feed lots, *Feeds, *Cattle, *Barley, *Waste disposal, Performance.
Identifiers: *Animal wastes, Cottonseed meal, *Supplement.

Three groups of pregnant cows grazing dry native range were supplemented with cottonseed meal, a mixture of 75 percent feedlot manure and 25 percent barley, or received no supplementation. This experiment lasted 84 days and was designed to give some insight into the possibility of feeding animal waste as an alternative to customary waste disposal procedures. Cows fed the manure-barley supplement consumed more feed than those fed the cottonseed meal supplement, but they also had a higher body weight. The individual cow variations in consumption of the manure-barley supplement were similar to those fed cottonseed meal supplement. This experiment shows that manure in combination with barley may be fed as a supplement to pregnant range cows. This provides an alternative to the use of high protein supplements. Using waste as a range supplement provides a means of recycling the nutrients contained in the waste and a method for waste disposal. (Russell-East Central).

1804 - A1, B1, E2 400

### FEEDLOT DESIGN AND CONSTRUCTION

D. Gill and M. D. Paine
Feedlot Management, 1973 Cattle Feeder's Planner, Vol. 14, No. 12, p. 34-36, 84 November, 1972. 1 fig.

Descriptors: *Feed lots, *Farm wastes, *Construction, *Design, Cattle, Costs, Waste storage, Waste disposal.
Identifiers: *Facilities, Equipment, Land disposal.

Feedlots should be constructed on a well drained site suitable for expansion. The center of the feedlot should be on the highest ground with 4-10 percent slopes away from it. The amount of land for the site, making allowances for facilities and for expansion of feedlot, should be about 1.4 acres per 100 head or 12 acres per 1,000 head. Adequate land for stockpiling waste should be available. To control runoff, a detention pond system should be used. Arrangement of facilities upon the site should be carefully considered. These facilities are (1) receiving and loading facilities, (2) pens, (3) alleys, (4) fencing, (5) water facilities, (6) windbreaks and shades as required and (7) feeding facilities. The size and location of these facilities is determined by herd size. Proper design of feedlots can reduce travel distances by approximately 25 percent compared to unplanned layouts. As a result, annual operating costs can be reduced by 6-10 percent. A modern feedlot must be designed to do an efficient job of feeding cattle, however, investment costs must be in line with the income potentials of cattle feeding. (Cameron-East Central).

1805 - A1. B1. D1. E2 200

### FEEDLOT WASTE MANAGEMENT SYSTEMS

R. C. Albin
Proceedings of the 1970 Beef Cattle Conference. Texas Tech University Animal Science Department, Lubbock, and Texas Tech University Research Center, Pantex, October 29, 1970, p. 8-17. 26 ref.

Descriptors: *Farm wastes, *Feed lots, Pollutants, Waste treatment, Waste disposal, Runoff, Aerobic conditions, Anaerobic conditions, Lagoons, Dehydration, Incineration, Recycling.
Identifiers: *Waste management systems, Land spreading, Composting.

The rapid expansion of cattle feedlots in the U. S. created the problem of handling and disposing of a vast quantity of feedlot wastes. The chemical and pollutional characteristics of feedlot wastes vary. The type of ration, size of cattle, climate, feedlot surface, and moisture content are all important factors in developing a waste management system. Numerous handling and disposal systems such as anaerobic and aerobic systems, lagoons, composting, oxidation ditches, dehydration, incineration, and nutrient recycling are available. However, final disposal of feedlot waste has been on land in most instances. The Great Plains Agricultural Council report recommended that research efforts be intensified in the areas of air pollution, land disposal, pollution under feedyards, systems analysis, complete economic evaluation of current alternatives for waste disposal, and socio-legal implication. (Dudley-East Central).

1806 - A1, B3, D4, E2 100

### FEEDLOT MANURE, A POTENTIALLY VALUABLE MATERIAL

Compost Corporation
Canyon, Texas
F. Sims
Compost Science, Vol. 14, No. 4, p. 24-25, July-August, 1973.

Descriptors: *Feed lots, *Farm wastes, *Waste treatment, *Waste disposal, Carbon, Fermentation, Costs, Texas, Crop production, Yields, Fertilizers.
Identifiers: *Manure, Toxic fermentation, Composting, Land spreading.

After reviewing other methods of feedlot waste disposal and/or reuse, Fletcher Sims turns to composting as perhaps the best alternative for waste handling. He quotes Dr. William Albrecht as saying that there is only enough carbon in the world to support 8,000 pounds of vegetation per land surface area. Thus this carbonaceous material should not be wasted. Fermentation or composting of feedlot wastes can mean vast improvement for poorly treated land and can serve as an alternative in feedlot waste handling problems. The main problem in composting is pathogens. Mr. Sims controls these by attaining a 140 degree temperature in treating the material. A Howard Rotovator is used in sizing and mixing the material. An inexpensive 600-ton-per-hour turning machine is used for spreading the material. Improved yields and improved nutrient balance may be attained through use of such composts on crop lands. (Cameron-East Central).

1807 - A1, B2, E3 400

### CONFINEMENT PAYS — IF WEATHER IS BAD!

Beef, p. 38-39, March, 1972.

Descriptors: *Confinement pens, *Costs, *Weather, Odor, Feed lots, Performance, Winter, Missouri, Waste storage, Waste disposal.
Identifiers: Waste handling, Manure, Land spreading.

At a Missouri Cattle Feeders Seminar, four speakers concluded that a confinement system will pay in a bad winter, but it's pretty marginal in a mild winter. Flint McRoberts felt that many factors determine whether a confinement barn is a sound investment. Among the factors were costs, stocking rates, outdoor lot conditions, time of year cattle are finished, number of cattle and adjoining pastures. Problems he mentioned were odors, manure handling, and flies. McRoberts listed alternate possibilities to confinement barns. Three University of Missouri experts compared open lots and confinement barns on cost, performance of cattle, and profitability. Neil F. Meador found the entire bill for a near-500 head operation to be $76,050 or $106 per head, allowing 20 square feet per animal. A. J. Dyer found that in a bad winter, the cattle in confinement gained faster. During a mild winter, the cattle in the outside lots gained slightly faster. Myron Bennett concluded that clearly, the barn would pay in a bad winter—but not in a mild one. (Cameron-East Central)

1808 - A1, B1, D4, E3 400

### MONFORT FUELS FEEDLOT AND PLANT WITH MANURE

Calf News, Vol. 12, No. 6, p. 12, June, 1974. 1 fig.

Descriptors: *Fuels, *Methane, *Farm wastes, *Waste treatment, Runoff, Natural gas, Feed lots, Anaerobic digestion, Costs, Odor, Fertilizers, Air pollution, Water pollution, Cattle.
Identifiers: Manure, Waste handling.

Monfort of Colorado, Inc., Greeley, has granted an option to Shelley B. Don and Associates of

Denver for construction of a facility to produce four million cubic feet of methane gas per day from manure. The process also reduces the odor associated with manure handling while enhancing the value of the residue as a fertilizer. An anaerobic digestion process would be utilized in the methane production within a closed or covered system which will not generate air or water pollution. There will be no water runoff from the process. Estimates on the cost of producing a thousand cubic feet of pipeline quality gas from a large efficient plant range from a low of 60 cents to three dollars. Conservative estimates place the yield of gas that can be produced from the manure of one animal on feed at 40 cubic feet per day. (Cameron-East Central).

## 1809 - B2, E3 400

### MANURE REFEEDING CUTS ODOR. SOLVES DISPOSAL PROBLEMS FOR THIS HOGMAN

B. Coffman
Farm Journal, Vol. 98, No. 10, p. H-6, November, 1974. 1 fig.

Descriptors: *Electricity, *Waste disposal, Hogs, Odor, Slurries.
Identifiers: *Manure, Oxidation ditch, *Paddlewheels, *Refeeding.

Instead of hauling hog manure, Paul Smart, Douglas County, Kansas, uses more than 3 dozen paddlewheels churning round the clock in oxidation ditches in 11 buildings. He buys about $13,000 of electricity annually to run the entire complex. In a 500 ft. long building completed this summer, Smart installed 12 custom-made paddlewheels, and is experimentally refeeding the oxidation ditch slurry in two pens. To refeed liquid manure, Smart's farm manager fashioned a 40 ft. long rectangular steel tubing (3" x 5") into a trough long enough to serve 2 pens. Liquid is lifted from the oxidation ditch by the paddlewheel as it churns at 100 rpm. The liquid flows through the trough by gravity—running continuously. Smart hasn't hauled manure in eight years, and he is marketing 13,000 to 15,000 head a year. (Cameron-East Central).

## 1810 - A1, B1, E2 400

### NO CHANGES IN FLY CONTROL FOR 1974

W. L. Gojmerac
Hoard's Dairyman, Vol. 119, No. 10, p. 674-675, May 25, 1974. 1 fig.

Descriptors: *Pest control, *Dairy industry, *Farm wastes, Waste treatment, Waste disposal, Organic wastes.
Identifiers: *Fly control, Manure, Sanitation, Insecticides, Decaying, Land spreading.

The basis of fly control or pest management is to consider the total environment and, by one of several different means, use management techniques which keep pests at a low or reasonable level. In the summer, all essential ingredients for fly production are present on a dairy farm. Maggots need decaying organic matter to live. It can be manure, wet hay or straw found under and around feed bunks, or even lawn clippings on a compost pile near the house. Sanitation used in reference to fly control refers to locating and removing decaying organic matter, such as cleaning calf pens and feed alleys regularly. Farmers can either remove the manure and stack it away from the buildings or spread it on a field if one is available. Insecticides can also be used by dairymen. Because of anticipated shortages and/or higher prices of insecticides in 1974, sanitation may be relied upon more. (Cameron-East Central)

## 1811 - A2, B2, E1, E2 400

### AVERT RUNOFF POLLUTION

W. Waltner and E. Waltner
Feedlot Management, Vol. 15, No. 5, p. 35-36, May, 1973. 3 fig.

Descriptors: *Runoff, *Feed lots, *Farm wastes, *Irrigation, *Evaporation, *Playas, *Lagoons, *Waste storage, *Waste disposal.
Identifiers: *Pollution, Pump-out system, Drainage, Dams, Land disposal.

Various evaporation and irrigation systems are used to prevent runoff pollution. Several specific feedlots and their runoff control measures are cited for feeders located in the Southwest. Some feedlot owners divert their feedlot runoff into playas. Others construct lagoons to catch the runoff and to provide a means of irrigation of adjoining land. Others use septic tanks to store the runoff water. The water is then pumped to irrigate adjoining fields. An Oklahoman constructed 2 storage ponds for conservative storage of the wastewater and ultimate evaporation when it is pumped into shallow evaporation pans. Solids are removed to a storage area for composting. These and other systems constructed to meet individual feedlot problems show that while big feedlots in the southwestern states are comparatively "young," they are mature in grappling with pollution runoff control. (Cameron-East Central).

## 1812 - B1 400

### FEEDING VARIATIONS CAN AFFECT WASTE

Feedlot Management, Vol. 15, No. 8, p. 22, August, 1973.

Descriptors: *Farm wastes, *Feed lots, Confinement pens, Texas, Cattle, Slopes.
Identifiers: *Waste accumulation, Roughage, Shade.

Three experiments were conducted to determine the effects of environmental factors upon feedlot waste accumulation. Results showed that neither shaded or unshaded pens nor slope of feedlot surface affected the amount of wastes produced. Rations with no roughage were fed and yielded 2.2 lbs. of waste per day. Ten percent roughage ration yielded 4.5 lbs. per day and 12 percent roughage yielded 5 lbs. of waste per day. A decrease of 12 percent to 0 percent roughage would significantly decrease the amount of waste accumulation without affecting animal performance. (Frantz-East Central)

## 1813 -A2, B2, C1, D1, E2 600

### EXPERIENCE WITH A SPRAY-RUNOFF SYSTEM FOR TREATING BEEF CATTLE FEEDLOT RUNOFF

Agricultural Engineering Department
Kansas State University
Manhattan
D. E. Eisenhauer, R. I. Lipper and H. L. Manges
Presented at 1973 Mid-Central Meeting, American Society of Agricultural Engineers, St. Joseph, Missouri, April 6-7, 1973, Paper No. MC-73-302. 22 p. 2 fig. 11 tab. 6 ref.

Descriptors: *Waste treatment, *Cattle, *Feed lots, *Runoff, Biochemical oxygen demand, Nitrogen, Salinity, Alkalinity, Soil profile.
Identifiers: *Spray-runoff system, *Pollution.

An experimental study was conducted to examine the spray-runoff technique as a possible alternative to disposal practices of beef cattle feedlot runoff. A detailed discussion of the construction of the system and test results are given. While treatment of the feedlot runoff by using the spray-runoff system did occur, a satisfactory effluent for direct release to the environment was not produced. Concentration reductions of BOD5 and Kjeldahl nitrogen were from 40-60 percent under the most favorable conditions. Mass reductions of $BOD_5$ and Kjeldahl nitrogen were as high as 90 percent. Accumulations of salt, sodium and potassium were found in the soil profile after 20 inches of the wastewater had been applied but no serious saline or alkali hazards had developed. (Dudley-East Central).

## 1814 - A2, A3, A4, A6, B1, E2, F2 300

### FEEDLOT POLLUTION

Public Health Engineer, Chief, Water Pollution Control Section, Division of Environmental Sanitation, Montana State Department of Health, Helena
D. G. Willems
Montana Agriculture--Focus on Improving the Environment, Annual Agricultural Seminar, Great Falls, Montana, December 3-4, 1970, p. 35-38.

Descriptors: *Feed lots, *Air pollution, *Water pollution, *Montana, *Regulation, *Legal aspects, *Permits, Waste disposal.
Identifiers: *Point source wastes, Land disposal.

The Montana water pollution control law prior to 1970 is delineated. Its greatest effect was upon industry and municipalities because their point source wastes were easy to identify and treat. But agricultural pollution must be met as well. Confined animal feeding drainage may well be the largest point source discharge in terms of organic material. The purpose of the proposed 1970 confined animal feeding regulations is: (1) to see that feedlot operations are properly located with respect to municipalities and residential areas, and (2) to control air and water pollution problems. The regulations would require new feedlots and expanding feedlots to secure a permit from the Department of Health as soon as the regulation is adopted. (White-East Central).

## 1815 - A5, B1, C3, D2 600

### ELECTRICALLY MANAGING WASTE FROM CAGED LAYERS

Agricultural Engineering Department
Georgia University
Athens
J. M. Allison and G. P. Bishop
Presented at 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973. 12 p. Paper No. 73-307, 3 fig. 4 tab. 3 ref.

Descriptors: *Farm wastes, *Management, *Poultry, *Ventilation, *Chemical properties, *Model studies, Moisture content, Biodegradation.
Identifiers: *Electric heat, *Moisture removal, *Deep-pits.

A model study was set up to study different methods of removing moisture from caged-layer wastes and to study changes in chemical composition of poultry manure under various drying conditions. Natural ventilation and 100 FPM were chosen for air movement for four various treatments. In all treatments the manure dried uniformly with forced air ventilation; little drying occurred in the control (no heat) and in the tile-drained treatments. The possibility was indicated for well distributed forced air ventilation to remove nearly as much moisture from caged-layer waste as from forced ventilation with electrical underheat. Chemical analyses of dried wastes are included. (Frantz-East Central).

## 1816 - B1 400

### THREE DAIRYMEN REPORT . . . HOW SLATTED FLOORS HAVE WORKED FOR THEM

D. W. Bates
Hoard's Dairyman, Vol. 119, No. 6, p. 384-385, March 25, 1974. 3 fig.

Descriptors: *Dairy industry, *Cattle, *Breeding, Minnesota, Waste storage, Farm wastes.
Identifiers: *Slatted floors, Heat detection, Barns

Slatted-floor barns with manure storage beneath have proved to be highly successful. This is a report on three such barns on Minnesota dairy farms. All have slatted floors with manure storage beneath; heavily insulated walls and flat, insulated ceilings; and mechanical ventilation. Landsverk Barn: The stall unit is 26 feet by 130 feet and the slatted section is 40 feet by 28 feet with a total of 120 free stalls for 130 cows. The manure tank has a capacity for about four months. Heat detection is much easier. Breeding problems are fewer. Eserle Barn: This barn has a self-emptying manure pit. The barn is 39 by 148 feet and houses 90 cows. There are 84 free stalls. The stalls are carpeted and no bedding is used. Heat detection is harder. There have been no breeding problems. Glawe Barn: The barn is 48 by 244 feet. There are 94 free stalls, 2 maternity pens, and 2 additional pens in the center of the barn. The manure tank provides storage for about 11 months. Rubber mats are set in the stalls and no bedding is used. Heat detection is easier and breeding repeats have been a problem. (Cartmell-East Central).

## 1817 - A5, B2, D1, E2, F1 400

### FLUSH SYSTEM CUTS CONFINEMENT COSTS

Beef, p. 12-15, February, 1973.

Descriptors: *Confinement pens, *Cattle, *Farm waste, *Costs, Waste treatment, Waste storage, Waste disposal, Nebraska, Lagoons, Anaerobic conditions, Odor.
Identifiers: *Flush system, Land disposal, Slatted floors.

A confinement feeding system has been developed which cuts costs from $100 per head to $80 per head. Above floor level is a semi-open building 510 feet long with closed north walls and an open south wall. Sliding doors along the north wall provide summer cooling. The building is divided into six pens which allow 18 square feet of pen space for each 1,000 lbs. of body weight. The building has a capacity of 1,050 head. On floor level, less than one half of the area is slatted. Outside aprons plus center islands are solid and sloped toward two slatted areas. These slats cover pits that are two feet deep. Wastes collected in these pits are flushed every two days into an anaerobic lagoon. These wastes are then applied to field crops. Problems have been odors and manure buildup on the gutters. Odor was overcome after the lagoon stabilized. Manure buildup was prevented by a wooden sled placed into the gutter. Water pressure drives it along to scrape the manure into the lagoon. (Marquard-East Central).

## 1818 - B2, D1, E2, F1 400

### BUDGET-PRICED CONFINEMENT?

Beef, Vol. 9, No. 9, p. 34-35, May, 1973. 2 fig.

Descriptors: *Confinement pens, *Costs, *Economics, *Cattle, *Farm wastes, *Management, Waste treatment, Waste storage, Waste disposal, Lagoons, Feed lots.
Identifiers: Land disposal, Slatted floor.

Two feedlot operator brainstorming sessions have resulted in untried plans for a confinement feeding system that cuts costs in half. The system uses a reduced slatted section running full length of the building instead of large gutters underneath, a much smaller flume arrangement is used. The wastes then run into an aerated lagoon. To control odors and winter freezing, warm air is pumped into the lagoon by three thirty horsepower motors. Land application is then used for final disposal. The cost of such a confinement unit will be under $70 a head. (Marquard-East Central).

## 1819 - B1, D1, E3 400

### GE ENTERS MANURE RECYCLING RACE

Calf News, Vol. 10, No. 4, p. 1, April, 1972, 2 fig.

Descriptors: *Farm wastes, *Feed lots, *Recycling, *Feeds, Proteins, Waste treatment, Waste disposal.
Identifiers: General Electric.

General Electric has committed one million dollars as a starter on a pilot plant that basically converts 2,000 pounds of farm wastes into 700 pounds of 60% protein feed supplement. The remainder of the matter is disposed in the form of carbon dioxide and hydrogen. How to market the process to the feed lots is undecided. (Frantz-East Central).

## 1820 - A1, B2, C5, D4, E2, F1 400

### GRASS-FILTER SYSTEMS . . . ANOTHER NEW RUNOFF CONTROL METHOD

Feedlot Management, Vol. 15, No. 5, p. 42, May, 1973.

Descriptors: *Waste treatment, *Waste disposal, *Runoff, *Control, *Farm wastes, *Fescues, Aerobic conditions, Lagoons, Feed lots, Kansas, Nutrients.
Identifiers: *Grass filter systems.

A fescue grass-filter system for absorbing and treating runoff is being tested at the 20,000 head Blackjack Feedyards, Inc., near Yates Center, Kansas. The system is based on fescue grass over which lagoon-collected runoff is sprayed irrigation-style. A buildup of soil bacteria which forms a mat on the ground digests the feedlot waste solids purifying the runoff. Mat depth must be kept at less than 1 inch at all times or the system will become anaerobic. Grass is necessary to hold the solids on the land so that the bacteria can multiply and digest the material. Fescue grass is a good choice for eastern Kansas because of its adaptability to heavy moisture. If winter icing problems and year round mat buildup can be combatted effectively, it is hoped that grass filter systems will be an acceptable method of treating and disposing of runoff. (Cartmell-East Central).

## 1821 - A1, B2, E2 100

### IRRIGATION OF PERENNIAL FORAGE CROPS WITH FEEDLOT RUNOFF

Agricultural Research Service
United States Department of Agriculture
Lincoln, Nebraska
N. P. Swanson, C. L. Linderman and J. R. Ellis.
Transactions of the ASAE, Vol. 17, No. 1, p. 144-147, January-February, 1974, 4 tab, 6 ref.

Descriptors: *Irrigation, *Runoff, *Feed lots, Forage grasses, *Waste disposal, Farm wastes, Cattle, Nebraska, Salts, Nutrients.

A study was conducted during 3 growing seasons, July 1, 1970 to October 1, 1972 on a silty clay loam soil. A maximum of 90 inches of runoff was applied to plots of perennial ryegrass, tall fescue, and Ladino clover. Accumulations of salt and nutrients found in the soil were not enough to be harmful. Although the effluent and 42.93 inches of precipitation exceeded the crops' water requirements, forage yields generally improved. There were no toxic contents in the forage which was of excellent quality. During the second season Ladino clover, a salt-sensitive crop, dominated the stands. It was indicated that undiluted runoff can be safely used to irrigate crops of low salt tolerance. (Frantz-East Central).

## 1822 - B2, F1 400

### KISSINGER'S CASE FOR CONFINEMENT

R. Sanders
Successful Farming, Vol. 71, No. 12, p. B1-B3, November-December, 1973. 4 fig.

Descriptors: *Confinement pens, *Farm wastes, *Cattle, Lagoons, Costs, Waste storage.
Identifiers: Slatted floor, Carcass improvement, Modified gutter flush building.

A Nebraska farmer-feeder moved into a new 1,050-head beef confinement building. It is a modified gutter flush building with a lagoon. Only a third of the floor is slatted. That is over a shallow flush pit which is flushed clean from water recycled from the deep lagoon. The design saves about $30 a head in construction costs and eliminates manure handling. It also yields a 1 percent improvement in hot carcass. One of the problems is the tendency of manure to stick to the rough sides of the pit. A wooden sled scraper pushed by water flow was developed to combat this problem. (Cartmell-East Central).

## 1823 - A1, B1 100

### GARDONA AS A FEED ADDITIVE FOR CONTROL OF FLY LARVAE IN COW MANURE

Animal Husbandry Research Division
Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland
R. W. Miller, C. H. Gordon, M. C. Bowman, M. Beroza and N. O. Morgan.
Journal of Economic Entomology, Vol. 63, No 5, p. 1420-1423, October, 1970, 3 tab, 10 ref.

Descriptors: *Feeds, *Additives, *Farm wastes, *Cattle, *Larvae, *Larvicides, Mortality, Dairy industry.
Identifiers: *Gardona, *Manure, Flies, Residues.

Four lactating dairy cows were fed 4 levels of Gardona, a larvicide, for 7 days. At levels of 22, 37, and 48 ppm. of the air-dry ration. Gardona killed 94 percent or more larvae of the house fly (Musca domestica) seeded onto the feces. The larval mortalities in the manure increased as the levels of Gardona in the ration was increased. But, after day 8, following the Gardona-ration feeding, larval mortalities began to decrease. In the first 2 trials almost no Gardona appeared in the cows' milk, but some milk samples from the 3rd trial contained Gardona residues. (Frantz-East Central).

## 1824 - B1 200

### THE REUSE OF BROILER LITTER WITH "LITTER LIFE" — ITS EFFECT ON PERFORMANCE

Poultry Research Associate
Delaware University
G. W. Chaloupka
Presented at Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 20-30, 1969, p. 41-49, 5 tab.

Descriptors: *Poultry, *Litter, *Performance, *Additives, Recycling, Economics, Costs, Diseases, Waste treatment.
Identifiers: *Litter Life, *Broilers.

In the past few years, the reuse of litter has become a common practice in most poultry operations. Complete clean out now takes place less often and in some cases not until a disease problem occurs. Research was conducted using the mineralized litter additive "Litter-Life" to see if broilers would perform as well on reused litter as on new litter. Two substation houses were used and "Litter Life" was added at a prescribed rate in one. When results were tabulated, it was found that birds grown on composted litter (with Litter Life) did not show a reduction in percent condemned as did the other house. However, one has to wonder whether management, such as light intensity and ventiliation has any effect on condemnation results. When expenses were compared, it was found that using new litter resulted in about $ .0030 more production cost per pound of broiler produced. Final results indicated that there is little doubt that reused litter can be used very satisfactorily in producing broilers whose performance surpasses that of those grown on new litter. (Russell-East Central).

1825 - A1, B1, C3, E2 300

### AREA NEEDED FOR LAND DISPOSAL OF BEEF AND SWINE WASTES

Specialist, North-Central Regional Extension Project
Iowa State University
Ames
D. H. Vanderholm
Cooperative Extension Service Publication Pm-552 Iowa State University, Ames, January, 1973. 2 p. 4 tab.

Descriptors: *Farm wastes, *Cattle, *Hogs, *Waste disposal, *Nitrogen, Phosphorus, Potassium, Formulation, Irrigation.
Identifiers: *Land disposal, *Pollution.

Formulas were established to determine the areas required for land disposal of hog and cattle wastes. The formulas are based upon an estimated 120 pounds nitrogen excreted per 1000 pound-cow and 18.25 pounds per 100 pound-hog, varying with ration, breed, and size of the animal. Nitrogen losses in treatment, storage, and handling have been established for six types of management systems to arrive at recommended disposal areas based upon 100 pound Nitrogen applications per acre. Corresponding P and K rates are given. Approximate nutrient content of various farm waste forms are given. (Frantz-East Central).

1826 - A5, A6, C1 700

### ATMOSPHERIC COMPOSITION IN AN ENCLOSED SWINE PRODUCTION BUILDING

J. A. Merkel
PhD Thesis, Agricultural Engineering Department, Iowa State University, 1968, 115 p. 23 fig, 3 tab, 63 ref.

Descriptors: *Hogs, *Confinement pens, *Farm wastes, *Chromatography, *Gases, *Atmosphere, Odor, Volatility, Sulfur compounds, Carbonates, Nitrogen compounds, Decomposing organic matter, Solubility, Equipment, Air pollution, Iowa.
Identifiers: *Atmospheric composition, *Enclosed swine production building.

A study was conducted to determine the gases present in a confined hog production system, other than those gaseous elements known to compose normal air. Volatile gases were collected from liquid manure samples in the AKSI-ISU Swine Atmosphere Research Laboratory. Positive identification of the gases was accomplished by established chromatographic components coupled with homologous plots and retention data. Volatile sulfur compounds identified included mercaptans, sulfides, and disulfates. Volatile nitrogen compounds were amines and amides. Volatile carbon compounds identified were methanol, ethanol, n-propanol, iso-propanol, n-butanol, iso butanol, iso-penethol, formaldelhyde, acetaldehyde, propianaldehyde, isobutraidehyde, valeraldehyde, heptaldehyde, octaldehyde, and decaldehyde. Amines, mercaptains, sulfides, and disulfides resulting from the breakdown of amino-acids were believed to compose most of the objectional odors from decomposing wastes. (Frantz-East Central).

1827 - B1, D1, E2 400

### THIN-BED DRYING OF POULTRY MANURE

Extension Agricultural Engineer
California University
Riverside
W. C. Fairbank and F. C. Price
Poultry Digest, Vol. 33, No. 388, p. 238-240, June, 1974. 3 fig.

Descriptors: *Farm wastes, *Drying, *Poultry, California, Odor, Aerobic conditions, Larvae, Waste treatment, Waste disposal, Fertilizers.
Identifiers: *Manure, Fly control, Land disposal, Composting.

California poultrymen have developed or adapted a number of schemes for the rapid natural drying of cage-house poultry manure. The primary objective is to reduce moisture content sufficiently to prevent development of fly larvae. On many ranches, this natural drying of manure has resulted in a high level of fly control during most of the year. Secondary benefits are the conversion of heavy, sticky, repulsive by-product to an easy-to-handle "fertilizer," and the prevention of further noxious odors by maintaining an aerobic condition. Thin-bed drying can be adapted to either solid or liquid manure collection systems. Thin-bed drying is basically a dry-season process that has limited use during wet weather. Fly control by thin-bed drying may require cleanout within one to seven days after the manure is dropped, depending on the season and the rate of natural drying. All of the manure-drying schemes, methods, and variations fall into the broad categories: (1) Manure spreader (solid or liquid); (2) Shallow bed with daily stirring; (3) Tiller drying. These are discussed in detail. (Cartmell-East Central).

1828 - A8, A9, B3, C5, D3 100

### THE INFLUENCE OF TEMPERATURE AND MOISTURE ON THE DISINFECTING ACTIVITY OF METHYL BROMIDE ON INFECTED POULTRY LITTER

Houghton Poultry Research Station, Houghton Huntingdon, England
E. G. Harry, W. B. Brown and G. Goodship
Journal of Applied Bacteriology, Vol. 36, No. 2, p. 343-350, June, 1973.

Descriptors: *Temperature, *Moisture content, *Farm wastes, *Poultry, *Waste treatment, *Disinfection, *Litter, Samonella.
Identifiers: *Methyl bromide.

The object of the present investigation was to determine the effect of moisture and temperature on the disinfecting activity of MeBr gas and to indicate the gas concentrations likely to be required to disinfect materials such as poultry house litter. The disinfecting activity of MeBr is related not only to the level of exposure to the gas, but also to the moisture content of the material exposed. The activity was also reduced at a reduced temperature. At 25 degrees, exposure to MeBr at a CT product of 800 mg h/1 was sufficient to prevent recovery of Salmonella Typhimurium from all samples with 42 percent moisture content and from 5 to 6 samples with 23 percent moisture content. It was isolated from all samples of 73 percent moisture content exposed to a CT product of 1600 mg h/1. At 10 degrees, exposure to MeBr at a CT product of 1600 mg h/1 was insufficient to prevent isolation of Salmonella Typhiumurium from all samples, irrespective of their moisture content. The E. coli present showed a susceptibility to MeBr similar to that of Salmonella Typhimurium, but micrococci were more resistant. Salmonella Typhimurium could be isolated from samples of dry litter exposed to levels of MeBr less than 800 mg h/1. The degree of disinfection achieved, in terms of percentage reduction, by levels as low as 100 mg h/1, was as high as 97 percent even at 10 degrees. (Cartmell-East Central)

1829 - A1, B2, D4 300

### THE TREATMENT OF MANURE IN OXIDATION DITCHES

Department of Agricultural Economics
Purdue University
Lafayette, Indiana
W. H. M. Morris
Paper submitted to Purdue Agricultural Experiment Station for publication. Research supported by Purdue Agricultural Station Projects No. 1349 and 1407, 34 p. 12 fig, 6 tab, 49 ref.

Descriptors: *Farm wastes, *Waste treatment, *Oxidation lagoons, Aerobic conditions, Odor, Sludge, Costs, Design, Bacteria, Nitrification, Denitrification.
Identifiers: *Manure, *Oxidation ditches.

The basic difference between aerobic and anaerobic waste treatment systems is that of odor control. The best aerobic treatment for odor control is an oxidation ditch. The basic form of the system is a race track shaped circuit. In the circuit there is an aeration rotor which provides oxygenation and circulation of the liquid. When a certain level of liquid is reached, a float stops the rotor and a time clock lets the liquid settle for 35 to 40 minutes. Then fresh water is pumped into the ditch and the effluent may run off through a siphon tube. Under this process there will be an accumulation of sludge. By maintaining the OC BOD$_5$ ration at 2:1, there will be some oxidation of the sludge. Sludge may be removed by sludge traps or pumping onto drying beds. Construction costs of the ditch average about $8.50-$14.00 head assuming 10.6 cu. ft head. Results given from test sites in Europe, United States and Canada indicate that the oxidation ditch can treat livestock manure aerobically. The problems they have encountered are sludge management, foaming, freezing and the determination of the proper aeration rotor size to prevent the ditch from going anaerobic. (Marquard-East Central).

1830 - B2, D1, E2, F2 300

### LIQUID MANURE MANAGEMENT FOR SWINE

Texas Agricultural Extension Service
Texas A&M University
College Station, Texas 77840
B. R. Stewart and J.M. Sweeten
Agricultural Extension Service paper, Texas A&M University, College Station, Texas, June 15, 1972. 24 p. 2 fig, 5 tab, 5 ref.

Descriptors: *Liquid wastes, *Farm wastes, *Management, *Hogs, Waste storage, Waste treatment, Waste disposal, Legal aspects, Lagoons, Regulation, Runoff, Confinement pens, Rates of application, Nutrients, Irrigation.
Identifiers: *Manure, Land disposal, Storage pits.

Texas regulatory guidelines are stated which give minimum requirements for preventing water pollution from confined feeding operations. Treated or untreated wastes may not be discharged to water courses except under rare rainfall events; therefore, alternative measures must be used. For confinement operations, this may mean: (1) daily scraping and cleaning of wastes for lagoon or pit storage, followed by land disposal, (2) use of slatted floors for collecting animal wastes in storage pits, followed by land disposal, or (3) use of slatted floors for catching animal wastes in shallow under-floor pits which discharge continuously into an outside lagoon. Pasture and open lot operations require solid waste management techniques, with the exception of having to catch rainfall runoff in retention ponds. Specific design and management requirements are given for liquid waste storage, treatment, and land disposal of swine wastes. (Marquard-East Central).

1831 - A2, B1, F1, F2 100

### EPA AND THE LIVESTOCK FEEDER

Executive Vice President
National Livestock Feeders Association
Omaha, Nebraska
B. Jenes
Agricultural Engineering, Vol. 55, No. 3, p. 30-31, March, 1974. 2 fig.

Descriptors: *Livestock, *Feed lots, *Water pollution control, *Costs, *Regulation, Runoff, Iowa.
Identifiers: *Environmental Protection Agency, Tenant farmers.

Livestock operators are faced with many installation and maintenance costs in maintaining adequate pollution control facilities. One of the problems is that such "investments" are not cost-reducing or production-increasing. It was calculated that an initial installation investment for surface runoff control facilities or over $700 million would be required for beef cattle, hog, lamb and dairy control facilities in this country in order to meet regulations requiring the containment of surface runoff from a 10-year, 24-hr, storm. Livestock operators usually must absorb cost increases. The cost of implementing environmental regulations may prove the exception if many producers are forced out of business. (Cartmell-East Central).

## 1832 - A1 100

### DETERMINATION OF AMMONIA IN AQUARIA AND IN SEA WATER USING THE AMMONIA ELECTRODE

**The New England Aquarium,**
**Boston, Massachusetts.**
**R. Gilbert, and A. M. Clay**
**Analytical Chemistry, Vol. 45, No. 9, p. 1757-1759, August, 1973. 1 fig, 2 tab, 7 ref.**

**Descriptors: *Ammonia, *Aquaria, *Sea Water, *Electrodes, Equipment, Sampling, Analysis, Ureas, Temperature, Hydrogen ion concentration.**
**Identifiers: *Reagents.**

**An experiment was conducted with an electrode for the analysis of ammonia in aqueous solutions. The electrode consisted of a hydrophobic gas-permeable membrane which separated the alkaline test solution from an internal solution 0.1 M in ammonium chloride. A glass pH electrode and a silver chloride reference electrode were immersed in the internal solution. Experimental apparatus, reagents, and procedures are given in detail. Electrode response is a function of ammonia concentration with faster response at higher ammonia levels. Several compounds were studied as possible interference in the ammonia analysis. Urea and the lowest molecular weight amino acid, glycine, did not interfere. Making a sample $10^{-4}$ M in dimethylamine did affect the electrode potential. The data indicated that the electrode provides an accurate means of analyzing ammonia in sea water and that it is usually more precise than the spectrophotometric method. (Cartmell-East Central).**

## 1833 - A1, B1, C2, C3, D1, E1, F2 100

### AGRICULTURAL WASTES

**Mississippi State University,**
**State College.**
**E. C. McGriff and A. Shindala.**
**Journal Water Pollution Control Federation, Vol. 45, No. 6 p. 1167-1173, June, 1973. 63 ref.**

**Descriptors: *Farm wastes, *Livestock, Chemical properties, Physical properties, Waste treatment, Lagoons, Fuels, Recycling, Waste disposal, Methane, Feeds, Legal aspects, Regulation, Permits.**
**Identifiers: *Agricultural wastes, Land disposal, Pyrolysis.**

**This review of data from many investigators concerns waste characteristics, pollution abatement practices, waste use and reuse, and waste management and legal action. Specific investigations are cited. No conclusions are made by the author himself. (Frantz-East Central).**

## 1834 - A2, B2, E2 400

### YOU HAVE TO "THINK MAINTENANCE" IN MANAGING FEEDLOT RUNOFF SYSTEMS

**Nebraska Farmer, February 3, 1973, 2 p. 3 fig.**

**Descriptors: *Feedlots, *Agricultural runoff, *Operation and maintenance, Costs.**
**Identifiers: *Debris basin, *Holding pond, Waste management.**

**Feedlots need proper maintenance. The best designed runoff control system can fail if it cannot be maintained properly. To keep cleaning chores easy, this feedlot operator has installed gates at the end of debris basins and lot fences on the top of debris dikes. These are used so that scraper equipment can remove manure solids which would have been left on the fence row and prevent the manure from being pushed under fence lines by livestock traffic. The final phase of the runoff system is a holding pond which holds storm runoff and pumps the wastes onto field crops. Problems of the system have been clogged slots caused by manure solids and hair and problems in pumping the wastes out of the holding pond onto field crops. (Marquard-East Central).**

## 1835 - A1, B1, D1, E1 300

### STRUCTURES AND ENVIRONMENT HANDBOOK

**Midwest Plan Service.**
**Publication MWPS-1, Midwest Plan Service, Iowa State University, September, 1973, 364 p.**

**Descriptors: *Planning, *Structures, *Environment, *Waste disposal, *Design, Livestock, Materials, Loads, Construction, Utilities.**
**Identifiers: *Handbooks, Fruit and vegetable storage.**

**This handbook is the fifth annual revision and first overall rewrite of a continuing program to bring facts, concepts, and relationships to teachers, students, and practitioners in the field of farm structures. Four large sections present structures, waste disposal, the environment, and the planning of a farmstead. The section on structures deals with materials, designs, loads, and construction of farm buildings. The environment section discusses fundamentals of environmental control of buildings. It then applies these fundamentals to different animal buildings. Also environmental considerations of fruit and vegetable storage is discussed in this section. Methods of waste disposal are presented in the next section with tips on construction. The planning section presents information on planning of livestock, crops, and water supply. The handbook is concluded with an appendix on beam formulas. (Russell-East Central).**

## 1836 - B1, E3 400

### FEEDING POULTRY MANURE TO ANIMALS

**Department of Poultry Science,**
**Texas A&M University,**
**College Station.**
**J. R. Couch.**
**Feedstuffs, Vol. 44, p. 24-25, 27, July 31, 1972. 6 ref.**

**Descriptors: *Feeds, *Excreta, Sheep, Nutrients, Performance.**
**Identifiers: *Dehydrated poultry waste, *Refeeding, Layers, Swine, Energy content.**

**This review of recent research, indicates that broiler chicks could tolerate five percent of dehydrated poultry waste (DPW). Growth decreased significantly when the percentage was raised to ten and twenty due to low energy content. No effect on egg taste or storage quality was detectable when laying hens were fed ten, twenty, or thirty percent DPW. DPW was recycled in the same poultry through 14 cycles or 12 days each in some tests. At 12-½ percent no adverse effects appeared, but at 25 percent the effects of the low energy content were clearly present. The age of manure at the time of drying is critical, and the method of drying is important. Manure for feed should be dried daily. Swine showed depressed feed conversion with as little as five percent DPW. Sheep can obtain up to fifty percent of their total nitrogen intake from DPW without adverse effects. Approximately forty nutritionists agree unanimously that "the best place to use dehydrated poultry waste was in beef cattle rations. (Whetstone, Parker and Wells-Texas Tech University).**

## 1837 - B2, D3, E1 700

### A MODEL STUDY OF MECHANICAL AERATION AS RELATED TO AGRICULTURAL WASTE DISPOSAL SYSTEM APPLICATION

**J. J. Kolega.**
**PhD Thesis, Department of Agricultural Engineering, Oklahoma State University, 1968, 89 p. 23 fig, 6 tab, 39 ref.**

**Descriptors: *Model studies, *Aeration, Equipment, Equations, Iowa, Slurries.**
**Identifiers: *Oxidation ditch, *Mechanical aerators, Scotland.**

**Objectives for the study were to evaluate the efficiency of mechanical aerators for agricultural waste disposal systems and to develop a prediction equation for describing the effectiveness of a rotor paddle aerator for transferring oxygen from air to a liquid. A unique laboratory method was developed for use in the engineering design and analysis of a paddle wheel aerator system. This procedure can be used to obtain quantitative prediction equations for estimating and evaluating mechanical aerator systems. The oxygen transfer coefficient per revolution of rotor can be defined by the prediction equation given. The oxygen transfer coefficient per revolution of rotor is analyzed. (Frantz-East Central).**

## 1838 - A2, C3 700

### WATER POLLUTION POTENTIAL OF CATTLE FEEDLOT RUNOFF

**J. R. Miner.**
**PhD Thesis, Department of Chemical Engineering, Kansas State University, 1967, 151 p. 19 fig, 37 tab, 85 ref.**

**Descriptors: *Feedlots, *Agricultural runoff, *Cattle, *Water pollution, *Irrigation, *Model studies, Kansas, Analysis, Chemical properties, Hydrology, Bacteria.**

**The characteristics of cattle feedlot wastes and their pollution potentials were evaluated in this model study. Twelve irrigation sprinklers provided simulated rainfall of 0.40 to 2.5 inches per hour onto two experimental feedlots. One lot was unsurfaced; the other was concrete surfaced. Data were collected to determine the amounts of rainfall necessary to produce runoff under various feedlot conditions. Runoff samples were collected and analyzed. A COD/BOD quotient was determined from a series of 48 runoff samples. Chemical constituents of the feedlot runoff were studied. Bacteriological populations in the runoff were found to be higher in warm weather and under conditions which produced maximum solubility of feedlot wastes. It was concluded that cattle feedlot runoff is a high strength organic waste. The decision on the best treatment and control measures is based on feedlot size, climate of the area, the nature of the receiving stream, the downstream water users, the space available for treatment facilities, and the overall cost of suitable alternates. (Frantz-East Central).**

## 1839 - B2, E1, F1 300

### ECONOMIC EVALUATION OF LIQUID MANURE DISPOSAL SYSTEMS FOR DAIRY CATTLE

**Agricultural Economist, Farm Production Economics Division Economic Research Service, United States Department of Agriculture, stationed at the University of Wisconsin, Madison.**
**N. D. Kimball, L. V. Lenschow, and R. E. Rieck.**
**Bulletin R2199, College of Agricultural and Life Science, University of Wisconsin, Madison, August, 1970, 24 p. 8 fig, 5 tab.**

**Descriptors: Liquid wastes, *Waste disposal systems, *Economics, *Costs, *Dairy industry, Waste storage, Equipment, Facilities, Labor.**

**This analysis reports experiences of the first Wisconsin dairy farmers who installed liquid manure disposal systems. These liquid manure systems include: (1) free-stall, all liquid, (2) free-stall, liquid-conventional, (3) stanchion, all-liquid, (4) stanchion, liquid-conventional. Comparisons are made of liquid manure storage, facility investments, annual costs, and costs and returns analysis. The most economical manure-handling system depends on many variables. The net disposal costs depend upon both the value of the manure and the cost of disposing the excrement. By changing the amount on nitrogen, phosphorus, and potassium recovered and making different assumptions regarding operating and ownership costs, the optimum system of manure disposal would change. In addition, installation costs are only the out-of-pocket costs —farmers did not report a charge for their own**

labor. Therefore, each farmer must ask himself whether the assumptions used in this study agree with his particular situation and then interpret the results accordingly. (Merryman-East Central).

1840 - A1, B3, E3 200

### PROCESSED POULTRY EXCRETA RECYCLED AS A FEED INGREDIENT

Department of Poultry Science,
Michigan State University,
H. C. Zindel and C. J. Flegal.
Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 103-118. 3 tab.

Descriptors: Nutrients, Performance, Sampling.
Identifiers: Dried Poultry Waste, *Refeeding, Pollution.

Growth trials were conducted to determine the nutritional value of the dehydrated poultry waste product. Feed efficiency appeared to be inversely proportional to the amount of dehydrated poultry waste in the ration. In growth trials, no significent differences were found in mean body weight of Leghorn type chicks fed up to 20 percent of dehydrated waste in their ration compared with broiler type chicks. When more than 5 percent of the dehydrated poultry waste was added to the ration, reduced four-week mean body weights resulted. No differences were found in egg production, shell thickness, or Haugh score when up to 40 percent of the diet consisted of dehydrated poultry waste. Also, taste tests indicated that the taste or flavor of eggs from chickens fed DPW was no different from eggs from chickens fed a normal ration. Tests were also conducted to see what would happen if the poultry manure from chickens receiving DPW was redried and fed again continuously. There was no egg production decrease; the crude protein level decreased; and the color of the dried material appeared to turn black. (Russell-East Central).

1841 - A5, C3 600

### PROCEDURE TO IDENTIFY MALODORS FROM ANIMAL WASTES

Department of Agricultural Engineering,
Ohio State University, Columbus.
R. K. White and E. P. Taiganides.
Presented at the 1969 Annual Meeting, American Society of Agricultural Engineers, Lafayette, Indiana, June 22-25, 1969, Paper No. 69-425, 13 p. 6 fig. 19 ref.

Descriptors: *Odor, *Gas chromatography, Sampling, Methodology, Analysis.

An equilibration collecting and concentration procedure of sampling odors from animal wastes for gas chromatographic analysis is presented and compared with other methods. Several methods of sampling are reviewed: sampling the source, salting out, selective chemical absorption and regeneration, cryogenic collection, and equilibration sampling. In the equilibration sampling technique used in this study, organic volatiles are passed over a liquid, stationary phase until the whole amount of the stationary phase reaches full equilibrium with the organic volatiles. Using a nonpolar stationary phase permits trapping the organic compounds while most of the water vapor passes through, provided the collector temperature is above the dew point. A variable stream splitter was installed in one of the columns of the gas chromatograph. This permitted sensory evaluation of each fraction separated so that qualitative, quantitative, and odor intensity analyses might be made on the significantly odorous peaks. Chromatograms of samples collected by the equilibrium technique indicated that some forty to fifty different compounds are present in the head space gases over dairy cattle wastes. This analysis of organic volatiles was considered to be more representative of the source than any of the other known procedures. (Solid Waste Information Retrieval System).

1842 - B2, D4, E3 400

### WLJ PREVIEWS FIRST COMMERCIAL MANURE SYSTEM

G. Richardson.
Western Livestock Journal, Vol. 51, No. 1, p. 1, 7, November 6, 1972. 2 fig.

Descriptors: *Aerobic treatment, Dairy industry, Feedlots, Foam separation, Recycling, Lagoons, Degradation (decomposition).
Identifiers: *Licom waste treatment system, *Odor control, Centrirator, DeLaval Separator Company, Pasteurization.

DeLaval Separator Company has introduced a new invention, the Licom Waste Treatment System, which can turn farm wastes into clear water and odor-free, pathogen-free mulch. Licom Systems I and II may be used for smaller operations while Licom III is used for those feedlots which must meet rigid ecological requirements. Licom I uses a liquid manure collecting pit which fills a reactor once weekly with wastes. In the reactor, aerobic bacterial action raises the temperature into the thermophilic range and in 5 to 7 days complete stabilization, decomposition, and pasteurization have occurred. Licom II uses the same procedure only with more reactors for more complete decomposition. Licom III is like Licom II with the addition of a flotation tank that separates fibrous matter from the liquid. For feedlots already using lagoons, a DeLaval Contrirator may be installed which will eliminate odors. (Marquard-East Central).

1843 - B2, E2 600

### WATER INTAKE RATES ON A SILT LOAM SOIL WITH VARIOUS MANURE APPLICATIONS

Agricultural Engineering Department,
Nebraska University, Lincoln.
O. E. Cross and P. E. Fischbach.
Presented at the 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-218, 13 p. 9 fig. 4 ref.

Descriptors: *Irrigation.
Identifiers: *Water intake rates, *Silt loam soil, *Manure applications, Application rate.

The application of manure to cultivated and irrigated soils changes the intake rate of irrigation water when compared to the intake rate of non-manured soils. This paper presents the findings of two years of irrigation study on manured soils. Conclusions were:

(1) The initial water intake rate increased as the quantity of manure application increased.
(2) The basic water intake rate increased as more time from date of manure application had elapsed.
(3) Manure application decreased the basic intake rate as compared to the basic intake rate of non-manured silt loan soil.
(4) Depth of plowing did not appreciably affect the basic intake rate. (Marquard-East Central).

1844 - B2, D1, E1 600

### FORMS OF NITROGEN IN ANIMAL WASTE

Agricultural Engineering Department,
Purdue University,
West Lafayette, Indiana.
R. E. Jones, J. C. Nye and A. C. Dale.
Presented at the 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-430, 15 p. 1 fig. 8 tab. 6 ref.

Descriptors: *Nitrogen compounds, Waste treatment, Waste storage, Climates, Aerobic conditions, Anaerobic conditions, Lagoons, Denitrification, Indiana.

Wastes from an aerobic lagoon, an anaerobic lagoon and a concrete manure storage tank were studied to determine seasonal variations on denitrification. Waste samples from all over Indiana were analyzed for Kjeldahl nitrogen, ammonium, and nitrate-nitrite nitrogen and solids. It was observed that type of livestock waste and type of waste management practice influenced the amounts of Kjeldahl nitrogen, in which most farm waste nitrogen was found to exist. Dairy wastes under either aerobic or anaerobic conditions are influenced by climatic variations. While approximately 65 percent of nitrogen is lost in aerobic conditions, greatest nitrogen loss in swine wastes occurred under anaerobic conditions. (Frantz-East Central).

1845 - A4, E2 600

### ANIMAL WASTE AND NITRATE MOVEMENT THROUGH SOIL

Agricultural Engineering Department,
Connecticut University, Storrs.
J. A. Lindley, A. C. Dale and J. V. Mannering.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 17 p. 6 fig, 11 tab, 6 ref.

Descriptors: *Animal wastes, *Groundwater pollution, *Nitrates, *Leaching, *Denitrification, Soil moisture.
Identifiers: *Application rates, *Land disposal, Silt loam, Sandy loam.

An evaluation of high application rates of animal wastes to land becomes necessary as the number of animals per acre of land increases. The application rate must be controlled to prevent ground water degradation. A laboratory study was done to evaluate the effects of waste management on nitrate movement through soil. The fate of nitrate is dependent on various conditions. The most important are soil moisture conditions and the presence of sufficient organic matter for microbial activity. Soil type might also affect nitrate movement. Leachates of very low nitrogen concentration can be produced even with waste application of 24.6 pounds of nitrate per acre-day. It was observed that the amount of nitrogen lost increases with increasing available energy (C:N ratio). (Kehl-East Central).

1846 - B3 600

### RISER INTAKE DESIGNS FOR FEEDLOT SOLIDS COLLECTION BASINS

Agricultural Research Service,
U.S. Department of Agriculture,
Lincoln, Nebraska.
C. L. Linderman, N. P. Swanson, and L. N. Mielke.
67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-3030, 7 p. 3 fig, 5 ref.

Descriptors: *Feedlots, *Solid wastes, Agricultural runoff.
Identifiers: *Collection basins, *Riser intake designs.

Given the size and shape of a feedlot debris basin, a riser intake and conduit can be designed to remove the runoff from the design storm within a desired time. Either corrugated metal pipe or plastic pipe with 5/8-inch drilled holes has proven very satisfactory for riser intakes. Comparisons of material requirements, installation labor, and operating experiences indicate that either type of intake is equally satisfactory, with the choice dependent on operator preference. Zinc-plated CMP is not excessively deteriorated by contact with runoff and animal wastes. If the basins are cleaned before solids accumulation seriously interferes with drainage, the intakes will operate with little maintenance. (Linderman, Swanson, & Mielke-USDA).

1847 - B1, E2, E3 600

### CABLE DRIVEN SCRAPERS FOR MANURE COLLECTION AND LIQUID SOLID SEPARATION

Agricultural Engineering Department,
North Dakota State University, Fargo.
G. L. Pratt, M. L. Buchanan and R. L. Witz.
Presented at 1974 Summer Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 14 p. 8 fig, 7 tab, 5 ref.

Descriptors: *Liquid wastes, *Solid wastes, *Separation techniques, Drying, Design.
Identifiers: *Cable driven scrapers, Slatted floors, Land spreading, Refeeding.

An integrated system for manure collection and liquid solid separation satisfies several desirable requirements for manure management in closed mechanically ventilated barns. These requirements include separation of manure from livestock by floor slats; daily removal of manure from barns; and separation of liquid wastes from solids for efficient handling and utilization. Pollution is kept to a minimum since no clean water is added to the system. Free liquid wastes make up about one third of the total weight of the liquid in the manure from animals. The fecal waste is removed from the building at 80 percent moisture and handled with conventional manure handling equipment. Because dewatering is accomplished by this system, dehydration is more feasible. Moisture removal from the fecal waste helps to control odors, reduces the bulk of material that must be handled, and puts it into a form that is more readily acceptable for utilization. (Cameron-East Central).

### 1848 - B3, E2 600

## MODEL OF NITRATE PRODUCTION AND MOVEMENT IN MANURE DISPOSAL PLOTS

Department of Agricultural Engineering,
Pennsylvania State University,
University Park.
R. M. Butler.
Presented at 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-426, 27 p. 7 fig, 6 tab, 10 ref.

Descriptors: *Computer models, *Nitrates, *Movement, Solids, Denitrification.
Identifiers: Land application.

A digital computer model was developed for simulating nitrate production and movement for wastes applied to soils. It accounted for nitrate production, nitrate uptake by plants, denitrification, and nitrate movement with the soil water. Manure was mixed with soil at rates of 0, 2.25 percent, 4.50 percent and 9.00 percent. Initially, nitrate production decreased, then increased exponentially. After 110 days, the rate of nitrate production decreased for all four treatments; after 200 days the nitrate-nitrogen content of the mixture was 23, 27, 32, and 48 mg/100 gm dry matter, respectively. The digital computer model was tested by comparing the predicted nitrate-nitrogen production and the predicted nitrate concentration of the soil water with field measurements for May through November, 1970. (Frantz-East Central).

### 1849 - A9, B3, C5 300

## THE USE OF FORMALDEHYDE FLAKES AS AN ANTIMICROBIAL AGENT IN BUILT-UP POULTRY LITTER

Department of Poultry Science,
North Carolina State University, Raleigh.
J. R. Veloso, P. B. Hamilton and C. R. Parkhurst.
Journal Series of the North Carolina State University Agricultural Experiment Station, Raleigh, Paper Number 3971, p. 78-83. 4 tab, 4 ref.

Descriptors: *Poultry, *Litter, *Waste treatment, Performance, Molds, Bacteria.
Identifiers: *Formaldehyde flakes.

This study was designed to investigate the effect of different concentrations of formaldehyde flakes on the bacterial and fungal populations of built-up litter and on the performance of broilers raised on such treated litter. The bacterial count of the litter containing 3 percent formaldehyde flakes was reduced to at least one-tenth of the control value for three weeks, after which the count returned to control values. The mold count was reduced at both 1 and 3 percent concentrations of formaldehyde flakes for about 2 weeks. The pH of the litter at 3 percent level of formaldehyde flakes was reduced significantly for three weeks. There was an increase in temperature of up to 4 degrees C above the control value in the litter containing 3 percent flakes and 3 degrees C in the litter containing 1 percent flakes. There were some possible side benefits to the use of formaldehyde flakes in litter. The number of insects and rodents in litter appeared to be considerably reduced. The litter treatment had no significant effect on the mean body weight, feed conversion, or mortality. (Cartmell-East Central).

### 1850 - A1, B2, E1, F2 300

## RULES AND REGULATIONS: CONFINED FEEDING OPERATIONS

Iowa Department of Environmental Quality.
Rules and Regulations: Confined Feeding Operations, Iowa Water Pollution Control Commission, 1971, 4 p.

Descriptors: *Regulation, *Iowa, *Waste water disposal, *Water pollution.
Identifiers: *Open feedlot, *Confinement feeding operation, *Registration.

An open feedlot (an unroofed or partially roofed adjacent or nearby animal enclosure on a single property) is defined in terms of specific animal populations and population densities. Confinement feeding operations (roofed or partially roofed adjacent or nearby animal enclosures on a single property from which wastes are removed as a liquid or semi-liquid) are defined in terms of maximum number of animals confined at one time. These data are given for beef cattle, dairy cattle, swine, sheep, turkeys, and chickens. Conditions requiring registration are outlined along with requirements for the facilities and for operation of the facilities. Feedlot pollution control facilities constructed in accordance with rules in effect at the time of construction shall not be required to be reconstructed due to subsequent rule changes unless the commission finds that waste discharge from such facilities is causing water pollution. Such facilities shall, however, be brought into compliance with rules in effect at the time of reconstructing, enlarging or otherwise modifying the confined feeding operations or control facilities. (Merryman-East Central).

### 1851 - A5, A6, B1, F2 300

## ODORS FROM LIVESTOCK PRODUCTION

Agricultural Engineering Department,
Oregon State University, Corvallis 97331.
J. R. Miner.
Report, Project Number S-802009, August, 1973, 127 p. 6 fig, 33 tab, 93 ref.

Descriptors: *Livestock, Ammonia, Measurement, Odor control, Management, Legal aspects, Nuisance.
Identifiers: Desorption, Identification, Feed additives, Chemical treatment.

Current livestock production techniques result in the generation of odors which have become a source of conflict between livestock producers and society. The odorous gases responsible for the nuisance are principally low molecular weight compounds released during anaerobic decomposition of manure. Manure management systems which control or modify this decomposition offer the greatest potential for odor control. Research to identify the chemical compounds present in odorous air from animal waste degradation has yielded about 45 compounds to date. The amines, mercaptans, organic acids and heterocyclic nitrogen compounds are generally regarded as being of greatest importance. Among the techniques for odor control are: (a) site selection away from populated areas and where adequate drainage exists, (b) maintain the animal areas as dry as possible and prevent the animals from becoming manure covered, (c) select manure handling systems which utilize aerobic environments for manure storage, (d) maintain an orderly operation free of accumulated manure and runoff water, (e) practice prompt disposal of dead animals and (f) use odor control chemicals when short term odor control is necessary, such as when manure storage tank contents must be field spread. (Miner-Oregon State University).

### 1852 - B1, D2 600

## VACUUM FILTRATION OF CATTLE MANURE

Sanitary Engineer, United States Army,
Security, Colorado.
L. F. Backer, R. L. Witz, G. L. Pratt, and M. L. Buchanan.
Presented at the 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, 1973, Paper No. 73-4531, 9 p. 8 fig, 3 ref.

Descriptors: Slurries, Sludge, Moisture content.
Identifiers: *Vacuum filtration, Manure, Liquid-solid separation.

A vacuum filter was used to separate solids from liquids in manure. Manure solids and liquids for the tests were gathered daily from a barn housing beef feeder cattle. Temperatures in the barn were controlled at about 45 degrees F. Two slurry mixtures were used, one having a moisture content of 87 percent and the second 91 percent. The type of filter fiber, the speed of rotation of the drum, and the percent submergence of the drum in the slurry were variables which affected the performance of the drum type vacuum filter. The yield of solids as affected by the drum speed, initial moisture content, and the drum submergence is presented. The initial cost of vacuum filter equipment is quite high. Cake and filtrate yields are generally small due to poor filtering characteristics of chemically unconditioned and undigested manure. If the manure were allowed to digest anaerobically, and if it were chemically conditioned, yields possibly would increase. Both practices would increase the cost of manure handling and disposal. (Cameron-East Central).

### 1853 - A8, B1, D3 100

## INTEGRATED FLY-CONTROL PROGRAM FOR CAGED POULTRY HOUSES

Department of Entomology,
North Carolina State University, Raleigh.
R. C. Axtell.
Journal of Economic Entomology, Vol. 63, No. 2, p. 400-405, April, 1970. 9 fig.

Descriptors: Insecticides, Manure.
Identifiers: *Fly control, *Caged poultry houses.

In two successive years, fly control programs were tested at three farms and compared with data from three untreated farms. The program was based on the following strategy: Selective application of insecticides would be against adult flies. Control measures would be applied early in the spring before flies appeared and would be repeated as needed. Finally, manure would remain undisturbed throughout the summer months when fly breeding occurs. Excellent control results are obtained by this method, especially when the first application of insecticide to walls and beams, where the adults breed, is done early, and then repeated four or five times during the season. Insecticide bait mixtures should be provided as well. This spray seems to have no effect on predacious mite fauna in manure. To maintain maximal populations of predators, manure should be partially removed at frequent intervals of low fly activity or removed only once a year in cool weather. These recommendations are founded on the fact that total removal of manure decimates mite population, while fresh droppings are most conducive to fly breeding. (Solid Waste Information Retrieval System).

1854 - A6, A9, B1 400

### TWO WAYS TO REDUCE AMMONIA LEVEL IN BROILER HOUSES

Extension Poultry Scientist.
Georgia University, Athens.
M. Y. Dendy.
Poultry Digest, Vol. 32, No. 377, p. 306-307, July, 1973. 1 fig.

Descriptors: *Ammonia, *Litter, Ventilation, Cleaning.
Identifiers: *Broilers, Respiratory diseases, Eye irritation.

Reused litter became common several years ago when it seemed evident that broilers on reused litter had lower condemnations due to Marek's disease. Another justification was that wood shavings and labor were getting scarce and high priced for cleaning out houses. However, Marek's vaccine is now in widespread use and substitute litter materials can usually be found if the feeder looks hard enough. The practice of reusing litter often causes unwarranted amounts of ammonia. Stress has been demonstrated to occur when ammonia exceeds 50 ppm. High levels of ammonia can cause severe eye irritation, blindness, and respiratory diseases in poultry. The solution to this problem is (1) a controlled ventilation system, or (2) more frequent clean-out. (Merryman-East Central).

1855 - B2 100

### A ROTATING FLIGHTED CYLINDER TO SEPARATE MANURE SOLIDS FROM WATER

Sanitary Engineer, Kansas State Department of Health and Environment, Topeka.
W. E. Verley and J. R. Miner.
Transactions of the ASAE, Vol. 17, No. 3, p. 518-520, 525, May-June, 1974. 6 fig. 3 tab, 3 ref.

Descriptors: *Solid wastes, *Separation techniques, *Settling basins, Weirs, Hydraulic transportation, Design.
Identifiers: *Rotating flighted cylinder.

Because of the advantages of solid-liquid separation in liquid manure systems and the high cost of present separation devices, a separator was developed at the Oregon State University dairy barn at Corvallis. The design concept was a series of circular weirs which formed a series of small settling basins with the weirs as the basin outlets. Solids settled into the basins which were moved slowly up an incline. The solids were then dumped at the upper end of the incline along with any trapped water. The separating device yielded these results. No plugging or other mechanical problems occured. The device failed to receive a representative sample of manure solids. The solids rich fraction discharged at the upper end contained too much water. The design was revised so that the shell diameter was increased to 24 in. and the basic flight depth was increased to 6 in. The flights were on a 4 in. spacing. This device has certain desirable features for solid-liquid separation. The construction of a larger diameter tube allows increase of volumetric capacity. It consumes little power and has no plugging problems. The concept is simple and has potential application wherever it is desired to concentrate solids or claim a water for reuse. (Merryman-East Central).

1856 - B1, C5, D4, E3 300

### RUMINANT FEEDING VALUES PREDICTED FOR ENSILED ANIMAL AND CROP WASTES

W. W. Saylor, T. A. Long, and L. L. Wilson.
Science in Agriculture, Vol. 20, No. 4, p. 10, Summer, 1973.

Descriptors: *Ruminants, *Feeds, *Silage, Nutrients, Alkalie.
Identifiers: *Ensiled animal and crop wastes, Digestibility.

Laboratory results indicate that ensiled animal and field waste can be used economically as a source of nutrients for ruminant animals, thereby reducing the pollution problem. Ground cornfield residue or oatstraw, 40 percent, was ensiled with cattle manure or poultry manure, 60 percent, on a fresh moisture basis. Sodium hydroxide, potassium hydroxide, or ammonium hydroxide — each an alkali — was added, at 4 percent of the treatment dry matter, to each combination. The moisture level of all silages was adjusted to 55 percent and all treatments were prepared in replicates of four. Each replicate was stored at 86 degrees F during a 60-day fermentation period. Contents were then analyzed for crude protein and digestible organic matter. Silages containing oat straw were superior to those made with cornfield residue. Average crude protein values were 13 percent for cattle waste and 14 percent for poultry waste. Digestible organic matter was greater for silages treated with ammonium hydroxide than for the other treatments. However, when the cost, corrosiveness, and possible dangers involved with the use of alkalies are considered, the increase in digestible organic matter is probably not sufficient to justify its use. The best silage in this study was the oat straw-poultry waste combination. (Merryman-East Central).

1857 - A1, B2, E2, F1 100

### LOW-COST DISPOSAL SYSTEMS FOR FEEDLOT RUNOFF

Agricultural Research Service,
U.S. Department of Agriculture,
Lincoln, Nebraska.
N. P. Swanson and C. L. Linderman.
Agricultural Engineering, Vol. 55, No. 11, p. 20-21, November, 1974. 3 fig.

Descriptors: *Agricultural runoff, *Feedlots, *Disposal, *Costs, Irrigation.
Identifiers: Sprinkler irrigation, Gravity flow.

Cattle feeders are required by law to control runoff from their feedlots. The most practical method for disposing of runoff is land disposal through irrigation. The feeder needs a low-cost disposal system that is fitted to a minimum land area. The Soil Conservation Service recommends a disposal area 1½ to 2 times larger than the contributing feedlot, but the specific area needed for disposal to empty the holding pond at any one time should be no longer than the feedlot. The runoff may be disposed of by a gravity flow system or through sprinkled irrigation. Gravity disposal through gated pipe, hoses, or single point discharge may require land preparation, some form of pump, protection from freezing, and it may require more labor. Sprinkler distribution requires more power, may require a reuse pit due to the runoff caused by the distribution, and may cause excess wetting during the seedling stage or just before harvest, thus damaging crops. Care must be taken in selecting irrigation components and in scheduling field applications. The larger the system, the more consideration should be given to application and distribution efficiencies. The most important considerations for smaller systems are low investment and labor costs. With either type, care must be taken to avoid ponding and mosquito breeding. Also the area should be located to take advantage of prevailing winds to avoid odor build-up near residences. (Merryman- East Central).

1858 - D4, E3 400

### FERMENTATION HEADS FOR HIGHER PRODUCTIVITY

Chemical and Engineering News, Vol. 51, No. 12, p. 32-34, March 19, 1973. 2 fig.

Descriptors: *Fermentation, Recycling, *Waste treatment, Proteins, Farm wastes, Mathematical models, Feeds, Bacteria.
Identifiers: Drugs, Animal wastes, General Electric.

This paper contends that closer control of a complex biological process—fermentation—promises large cuts in the costs of making drugs and protein, and of recycling wastes. Scientists are now mathematically modeling fermentation processes and setting up computer systems to find the best set of reaction parameters. The energy squeeze could also figure largely in the future of fermentation. The use of a computer along with fermentation has provided a system that can log and instantly reduce and analyze physical and metabolic parameters of fermentation. As to applications of the process, a microbolic attack on animal wastes currently involves General Electric in a project raising high-protein bacteria on animal wastes. Product bacteria would be tested as animal supplements. The market could also include fermentation applications in drug processing and enzyme production. (Solid Waste Information Retrieval System).

1859 - B3, D3, E3 400

### PROCESS CONVERTS ANIMAL WASTES TO OIL

Chemical and Engineering News, Vol. 49, No. 33, p. 43, August 16, 1971. 1 fig.

Descriptors: *Farm wastes, *Oil, *Feed lots, *Energy, *Waste treatment, *Waste disposal, Steam, Cellulose, Hydrogenation, Research and development, Fuels.
Identifiers: *Animal wastes, Carbon monoxide.

The U. S. Bureau of Mines' Pittsburgh Energy Research Center has developed an effective process, using carbon monoxide and steam, to convert manure or any cellulosic waste to oil with a percent yield. The mechanism of the reaction is unknown, although it may proceed through a formate ion. The constant product is a heavy oil with an energy content of 14,000 to 16,000 Btu per lb. The oil is paraffinic, and it has a low sulfur content of 0.35 percent which could prove useful in the future to the prevention of urban air pollution. (Solid Waste Information Retrieval System).

1860 - A2, A3, C3 300

### ESTIMATING NUTRIENT LOADINGS OF LAKES FROM NON-POINT SOURCES

Wisconsin University, Madison. Water Resources Center.
P. D. Uttormark, J. D. Chapin, and K. M, Green.
Environmental Protection Agency report number, EPA-660/3-74-020, August, 1974, 112 p. 5 fig, 31 tab, 133 ref.

Descriptors: *Nutrients, *Eutrophication, *Control, Management, Drainage, Nitrogen, Phosphorus, Agriculture, Estimating, Chemical properties, Runoff, Groundwater, Fallout, Sewage, Precipitation (Atmospheric), Seepage, Urban runoff, Forests, Marshes, Wetlands, Septic tanks.
Identifiers: Lake management, Nutrient load, Nutrient sources.

Data describing nutrient contributions from non-point sources were compiled from the literature, converted to kg/ha/yr, and tabulated in a format convenient for estimating nutrient loadings of lakes. Contributing areas are subdivided according to general use categories, including agricultural, urban, forested, and wetland. Data describing nutrient transport by groundwater seepage and bulk precipitation are given along with data for nutrient contributions from manure handling, septic tanks, and agricultural fertilizers. Nutrient content of urban runoff was the highest; forested areas were lowest. Nutrient expert data for agricultural lands were tabulated as seepage through vertical soil profile, overland runoff, and transport by streams draining agricultural wastersheds. The latter group was judged to be most applicable for estimating nutrient loading of lakes. Marshes appear to temporarily store phosphorus and nitrogen during the growing season and release them at a later time; net nutrient runoff is estimated to be near zero. Nutrient contributions to lakes from groundwater seepage require site-specific information for assessment. Phosphorus and nitrogen transport by groundwater can be significant, Atmospheric contributions of nitrogen are large in some areas. The technique of estimating nutrient loadings of lakes requires considerable judgment in selecting runoff coefficients; however, the approach provides insight into potential management options. (Uttormark-Wisconsin).

1861 - B3, E3 400

### INCLUSION OF DRIED POULTRY WASTE AS A FEED INGREDIENT IN CATFISH RATIONS

Texas Agricultural and Extension Service, Texas A & M University, College Station.
J. C. Fowler and J. T. Lock.
Feedstuffs, Vol. 46, No. 44, p. 36, Oct. 28, 1974. 1 fig, 2 tab, 4 ref.

Descriptors: *Catfishes, *Diets, Proteins, Performance, Taste.
Identifiers: *Dried poultry waste.

A study was done to determine the feasibility of including air dried poultry waste as a feed ingredient in catfish rations. Air dried manure was used in the diets at a dietary level of 25 percent. All diets were calculated to contain essentially equal amounts of crude protein assuming that the hen manure contained 21 percent protein. Catfish consuming diets containing air-dried poultry waste had better weight gain than catfish consuming the control diet over the 150 day feeding period, Taste panel evaluation of the test tissue and control tissue revealed no significant differences. (Cameron-East Central).

1862 - B2, D1 600

### BASIC PERFORMANCE PARAMETERS FOR OXYGENATION AND LIQUID CIRCULATION IN ROTOR-AERATED LIQUID WASTE SYSTEMS

Agricultural Engineering Department, Oklahoma State University, Stillwater.
G. L. Nelson, J. J. Kolega, U. Agena, Q. Graves, and G. Hoffman.
Presented at 1968 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, Dec. 10-13, Paper No. 68-932, 41 p. 15 fig, 5 tab, 17 ref.

Descriptors: *Rotors, *Performance, *Liquid wastes, Equations.
Identifiers: Parameters, Rotor-aerated tank, Oxygen transfer, Liquid circulation.

A study was made which concerned performance characteristics of rotor-aerated ditch or tank systems for livestock wastes. The purpose of this study was to: (1) identify the physical parameters that characterize oxygen transfer and liquid circulation effects in a rotor-aerated liquid waste system; and (2) based on these parameters, to develop prediction equations for oxygen transfer and for liquid circulation effects for one class of rotors. The study included experiments with two laboratory models, one each for oxygenation and liquid circulation. Conclusions drawn from the study include: (1) For a class of rotors, the dimensionless oxygen transfer parameter can be predicted for system design and operating purposes, (2) the oxygen transfer coefficients, $k_M$, of two geometrically similar rotors are directly proportional to the ratios of the products, (3) liquid velocity for rotor-driven circulation in a ditch can be estimated, (4) the ratio of channel length to width is non-critical in the range 5.8 to 10.0, and (5) the rotor Froude number is critical below a value of 0.15 for liquid circulation effects in a rotor-driven ditch. (Cameron-East Central).

1863 - A9 700

### METHODS FOR RAPID IDENTIFICATION AND ENUMERATION OF STREPTOCOCCUS BOVIS FROM WATER

L. R. Koupal
MS Thesis, Bacteriology Department, South Dakota State University, 1969, 53 p. 9 fig, 5 tab.

Descriptors: *Streptococcus bovis, *Analytical techniques, *Pathogenic bacteria, *Water pollution.
Identifiers: Identification, Raffinose.

This investigation was undertaken to find an isolation medium and a technique to make isolation of Streptococcus Bovis less difficult and more consistent. An attempt was also made to gather more information as to the length of time Streptococcus Bovis may be viable in a stream so that the value of this microorganism as a tracer for animal fecal pollution will be more clear. It was determined that raffinose serves to make the basal medium more selective for Streptococcus Bovis and that sodium azide at concentrations of 0,04 percent and greater inhibits the growth of Streptococcus Bovis. A 25 percent carbon dioxide and 75 percent nitrogen atmosphere over the cultures enhances the growth of Streptococcus Bovis while it maintains selectivity of a given medium. The starch agar layer method used in conjunction with the membrane filter and spread plate technique is an excellent method for rapid screening for streptococcus Bovis. Streptococcus Bovis exhibited the greatest persistence under the following conditions: in an organic concentration of .73 mg nitrogen per 100 ml. as peptone, in an aerated state, and at a temperature of 10 degrees C. (Cartmell-East Central).

1864 - C5, D1 700

### KINETICS OF GROWTH AND CONVERSION OF NUTRIENTS BY RUMEN MICROBES IN SOLUTIONS OF POULTRY EXCRETA

H. E. Hamilton
PhD Thesis, University of Kentucky, Lexington, May, 1971, 139 p. 64 fig, 4 tab, 32 ref.

Descriptors: *Kinetics, *Nutrients, *Conversion, *Poultry, Nitrogen, Microorganisms, Sampling, Fermentation, Incubation, Anaerobic conditions, Hydrogen ion concentration, Ethers.
Identifiers: Growth, Excreta, Rumen.

An experimental investigation was conducted to determine the effects of pH and manure when fermented with rumen fluid as an inoculum. All sampling, fermenting, and incubation were strictly anaerobic. Excreta from hens fed a drug-free diet was blended and diluted with water, sterilized, and placed in fermentation equipment with an indirectly driven agitator, automatic pH controller, temperature controller, foam controller, and sampling device. The solution was then inoculated with rumen fluid and fermented anaerobically for 48 hours. Samples were taken and freeze-dried as fermentation progressed. The dried samples were ground and proximate analyses made to quantitatively determine the major components. The specific growth of the microorganisms was higher for solution of pH 6,8 than for pH of 6.3 and 7.3. Maximum population was reached after 14 to 22 hours. There was no significant change in nitrogen and ether extract indices during the first 14 hours of fermentation: after which nitrogen index decreased and the ether extract index increased. The ash index showed no change during the first 6 hours of fermentation but steadily increased after that time. (Cartmell-East Central).

1865 - B3, D4, E2 300

### ANIMAL WASTE COMPOSTING WITH CARBONACEOUS MATERIAL

W. S. Galler
Summaries of Solid Waste Research and Training Grants, EPA Publication No. SW-5r. p. 6-7, 1971.

Descriptors: *Poultry, Nitrogen, Carbon.
Identifiers: *Animal wastes, *Composting, Sawdust, Soil amendment.

The objectives of the research reported are "to develop a process for composting a combination of chicken manure as a source of nitrogen and sawdust initially as a source of carbon to produce a valuable soil amendment." Laboratory studies of combinations of manure and sawdust with carbon-to-nitrogen ratios of 25:1 to 40:1 found them to be nutritionally balanced for microbial growth. The compost has proven to be a valuable soil conditioner. Swine manure may also be composted satisfactorily with sawdust although the mixture required a week to become thermophilic as opposed to one to two days for the poultry manure. (Whetstone, Parker, Wells—Texas Tech University).

1866 - B2, D4, E1 300

### PHOTOSYNTHETIC RECLAMATION OF AGRICULTURAL SOLID AND LIQUID WASTES

W. J. Oswald
Summaries of Solid Waste Research and Training Grants, EPA Publication No. SW-5r. p. 85-86, 1971, 5 ref.

Descriptors: *Solid wastes, *Liquid wastes, *Agriculture, Poultry, Anaerobic digestion, Algae, Effluent, Aeration, Costs.
Identifiers: *Photosynthetic reclamation.

In a pilot plant at Richmond, California, the wastes from a hen house were fermented in an anaerobic digestion tank with the effluent feeding directly into an algae pond. Water from the pond was used for flushing in the hen house, and the algae were fed to the hens. The pond was aerated during the winter. Algae production was 30 to 40 tons (dry wt.) per acre of pond. "The net waste-handling cost would be one cent or less per dozen eggs." (Whetstone, Parker, Wells-Texas Tech University).

1867 - A1, B1, D1, E2, E3 200

### SURMOUNTING THE POULTRY WASTE PROBLEM

Department of Poultry Science
Cornell University
Ithaca, New York
C. E. Ostrander
Proceedings and Abstracts, XV World's Poultry Congress & Exposition, New Orleans, Louisiana, August 11-16, 1974, p. 219-221, 6 ref.

Descriptors: *Poultry, *Excreta, Anaerobic digestion, Dehydration, Odor, Methane, Fertilizers.
Identifiers: *Waste management, Deep pit house, High rise house, Oxidation ditch, Aerated pond, Soil injection.

Choice of a poultry waste management system is dependent upon location, climate, size of operation, amount of land, cropping possibilities, etc. Among poultry waste management choices are the following: (1) deep pit, (2) high rise, (3) anaerobic systems, (4) aerobic systems such as oxidation ditches and surface aeration, (5) soil injection, (6) dehydration and (7) methane production. Of the two dry systems (deep pit and high rise), the high rise house maintains dry manure conditions more easily. For both systems, groundwater seepage, excess water, and air circulation may be problems. Of the liquid systems, an anaerobic system would only be recommended for an isolated area due to its odor. Conversely, an aerobic system would be better for a populated area. Where odors are a problem at spreading time, soil injection may be used to eliminate the problem. Actual recycling of farm wastes through methane production is still largely experimental. The use of dehydrated manure as a fertilizer is also being eyed with interest. (Merryman-East Central).

1868 - A1, B2, D4, E2, E3 200

## DIGESTER — A SOURCE OF BIOELECTRICITY

The Papcock Farms, Inc.
Harni Road
Baroda—390002, Gujarat, India
H. B. Patel and J. D. Patel
Proceedings and Abstracts, XV World's Poultry Congress & Exposition, New Orleans, Louisiana, August 11-16, 1974, p. 221-223. 7 ref.

Descriptors: *Recycling, *Gases, *Poultry.
Identifiers: *Digester, *Bioelectricity, *Biofertilizer.

At Papcock Farms, Inc. in India, a self-contained system of 'Bioconversion' was established to convert poultry or animal wastes into an energy source and a biofertilizer. The wastes are mixed with water at a 1.2 ratio and fed to a 'digester.' In the digester the wastes undergo two basic processes—liquifaction and gasification. The gas is collected and used as fuel to run incubator brooders and a small gas engine. The gas is also used for cooking for a family of 40. The installation produces about 20 cubic meters of gas per day. The digested slurry is then nitrified by blue-green algae and used as a 'biofertilizer' on crop lands. This system has been used successfully since 1963 without soil or water pollution, odor, or occurrence of fecal-borne diseases. A similar, but somewhat more sophisticated, study has been performed by Dr. Frederic Sisler of the United States. A brief description is given. (Merryman-East Central).

1869 - A9, B3, E2, F1, F2 200

## RECYCLING DRIED POULTRY WASTES AS A WASTE MANAGEMENT SYSTEM

Agricultural Research Council's Poultry Research Centre,
King's Buildings, West Mains Road, Edinburgh EH9 3JS
Scotland
R. Blair
Proceedings and Abstracts, XV World's Congress & Exposition, New Orleans, Louisiana, August 11-16, 1974, p. 225-227. 5 ref.

Descriptors: *Recycling, Ruminants, Economics, Additives, Legal aspects, Public health.
Identifiers: *Dried poultry waste, *Dried poultry litter, *Waste management, *Refeeding, Nonruminants.

Solid waste as voided is about 80 percent water. Its bulk may be reduced through drying techniques. In this paper, dried poultry waste (DPW) and dried poultry litter (DPL) are considered. The main difference in DPL and DPW is a higher content of crude fiber in DPL due to the mixture of the droppings with litter. Studies have indicated that DPW and DPL are economic feedstuffs for ruminants and that they can play an important part in keeping down feed costs. They may also be used to supplement nonruminant diets with the same effect. Variability of composition of poultry waste can be a drawback, however. Also, recycling of animal waste is banned in most EEC countries and in the US. In the UK the use of DPW is not prohibited unless it can be shown that the feed contains deleterious ingredients. DPL is in a different category since the presence of litter in a feed has to be declared. The main aim of legislation must be to prevent farm animals and the public from being exposed to unnecessary hazards as a result of recycling. DPL presents more of a potential from residues than DPW since birds on deep litter may also contain mycotoxins and wood preservation chemicals. Feeding this type of litter to ruminants would be inadvisable. Although risks exist, tests for bacterial contamination, odor and taste on milk, meat and eggs from animals fed DPW have indicated that they are acceptable for human consumption. (Merryman-East Central).

1870 - A9, E3 200

## EVALUATION OF POULTRY MANURE AS A FEED INGREDIENT

Department of Poultry Science
Texas A&M University
College Station
J. R. Couch
Proceedings and Abstracts, XV World's Poultry Congress & Exposition, New Orleans, Louisiana, August 11-16, 1974, p. 231. 24 ref.

Descriptors: Poultry, *Excreta, Performance.
Identifiers: *Dried poultry waste, *Refeeding.

An intensive interest has developed toward using DPW from caged layers in feeds for chicks, laying hens and turkeys. Dried poultry waste is defined by the Association of American Feed Control Officials as "a product composed of freshly collected feces from commercial laying or broiler flocks not receiving medicants . . . thermally dehydrated to a moisture content of not more than 15 percent. It shall not contain any substances at harmful levels. It shall be free of extraneous materials . . . The product shall be labeled to show the minimum percent fiber. It may be used as an ingredient in sheep, lamb, beef and dairy cattle, broiler and layer chick feeds. Broiler and layer rations shall be limited to 20 and 25 percent DPW respectively. DPW has been fed to chicks and broilers, laying hens, and turkeys with the following results. (1) Chicks and broilers—They can tolerate 5 percent DPW with little effect on growth and feed conversion. Weights and feed conversion are depressed as the level of DPW is increased up to 20 percent. Increase of DPW causes an increase of feed intake and fecal volume. Uric acid in the DPW causes an increase of feed intake and fecal volume. Uric acid in the DPW cannot be utilized by a chick and may even be toxic. ((2) Laying hens—DPW can be used at levels of 22.5-25 percent without adversely affecting egg production or feed conversion. Increase of DPW causes increase of feed intake and fecal volume. (3) Growing turkeys have been fed DPW at levels of 5, 10, and 30 percent, 9-17 weeks, inclusive, without significant effect on weight gain but with an adverse effect on feed conversion as the level of DPW was increased. (Merryman-East Central).

1871 - A5, B1, D1 200

## THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODORS AND DECOMPOSE ORGANIC WASTES FOUND IN POULTRY PRODUCING UNITS AND PROCESSING PLANTS

Development, Big Dutchman, A Division of United States Industries, Inc.
Zeeland, Michigan
J. F. Bergdoll
Proceedings and Abstracts, XV World's Poultry Congress & Exposition, New Orleans, Louisiana, August, 11-16, 1974, p. 233-235.

Descriptors: *Bacteria, *Enzymes, *Odor control, *Organic wastes, *Waste treatment.
Identifiers: *Poultry houses, Poultry processing plants, *Poultry rendering plants.

Extensive work was done using dried bacteria cultures and enzymes to control ammonia and other odors produced by laying hens. Work was also done with waste from poultry processing plants and poultry by-product rendering plants. After much experimentation a bacteria product was standardized which was primarily composed of the following, per gram: 4 billion aerobic bacteria, 1.5 billion anaerobes, 15,000 casein digested units Protease, 190,000 starch liquefying units Amylase, 80 olive oil units, or (8TAU) Lipase. The strains were basically Bacillus subtilis and Asperigillus oryzae. In addition, there were small quantities of buffers, additional fermentation accelerating enzymes, organic surfactants, anti-foaming agents, calcium carbonate, sodium bicarbonate, U.S.P. pine oil and several natural oxidating agents. The additives were varied slightly, depending on whether the product was used to liquefy manure in a pit or used on manure under a cage. Several tests were conducted which used the product to control odor, to reduce volume of organic waste, to liquefy wastes, and to remove fat and buildup of blood in drain lines. In all cases, the product gave satisfactory results. It was found that odors and harmful gases can be reduced in poultry houses, poultry processing plants, and poultry rendering plants by the proper use of the bacteria product. The total volume of manure can be reduced from one-third to one-half. Fly control was an added boon. In all cases, the operator and caretakers felt that working conditions were vastly improved by use of the product. (Merryman-East Central).

1872 - B1, D1, E2, F4 100

## AGRICULTURE: THE SEEDS OF A PROBLEM

Editor
Biomedical News
W. E. Small
Technology Review, Vol. 73, No. 6, p. 48-53, April, 1971. 4 fig.

Descriptors: *Agriculture, *Farm wastes, *Forestry, *Waste disposal.
Identifiers: *Land disposal, Pollution.

Farming and forestry produce more waste and contamination in the United States than do cities. Livestock and poultry waste is estimated at 1.7 billion tons annually. Biological wastes that were formerly recycled now accumulate, presenting greater disposal problems. Farmers generally ignore the value of organic fertilizers due to high labor and equipment costs. Groundwater pollution caused by disposal of livestock and poultry waste may effect changes in taste, odor, and color of the water. Manure treatment may increase nitrate levels in adjacent water supplies. Forestry leaves 25 million tons of debris each year, some of it beneficial, some of it a fire hazard or breeding place for disease and pests. The cities are turning to the farms for help with disposal of urban wastes. Various recycling schemes have been advanced to get valuable solid wastes back into the soil. Solids removed as sludge from domestic waste waters can be used for spreader application after treatment. Digested sludge is applied to agricultural lands as a liquid with less than 10 percent of solids. If applied at the rate of 2 in. per acre, it will supply over 500 lb. nitrogen, 200 to 300 lb. phosphorus and 40 to 80 lbs. potassium. The effects of long-term continuous applications are still under study. (Solid Waste Information Retrieval System).

1873 - B2, C5, D3, D4 300

## DEVELOPMENT AND DEMONSTRATION OF NUTRIENT REMOVAL FROM ANIMAL WASTES

Agricultural Waste Management Program
Cornell University
Ithaca, New York
R. C. Loehr, T. B. X. Prakasam, E. G. Srinath, and Y. D. Joo.
Environmental Protection Agency Report Number, EPA-R2-73-095, January, 1973, 340 p. 100 fig, 41 tab, 194 ref.

Descriptors: *Nitrogen control, *Phosphorus control, Nitrification, Denitrification, Ammonia stripping, Chemical precipitation, Predictive relationships, Animal wastes.
Identifiers: *Nutrient control, *Animal waste treatment processes.

Laboratory and pilot plant studies evaluated the feasibility of (a) chemical precipitation, (b) ammonia removal by aeration, and (c) nitrification and denitrification as methods to remove nitrogen, phosphorus, and color from animal wastewaters. Poultry and dairy manure solutions were used over a broad concentration range to illustrate the fundamentals of the processes as applied to these wastes and to demonstrate the fundamentals of the processes as applied to these wastes and to demonstrate the applicability of the processes. Alum, lime, and ferric chloride can be used for phosphorus control in animal wastewater although the chemical costs are from 2-10 times those quoted for municipal wastewater. Two predictive relationships were determined that appear useful for design and operation of phosphate were developed and verified to determine the ammonia loss under specific environmental conditions. Nitrification followed by denitrification was found to be technically feasible. Parameters affecting the design and performance of these processes with animal wastewater were identified. (Loehr-Cornell).

1874 - B3, E3 300

### RECYCLING ANIMAL WASTES AS PROTEIN SOURCES

L. W. Smith
Alternative Sources of Protein for Animal Production, Proceedings of a Symposium, Virginia Polytechnic Institute and State University, Blacksburg, July 31, 1972, p. 146-173. 2 fig, 5 tab.

Descriptors: *Recycling, *Animal wastes, *Proteins, Nitrogen compounds, Diets.
Identifiers: *Refeeding.

The purpose of this literature review was to discuss the use of animal wastes as a protein source of various kinds of farm animals as related to the diversity of nitrogen compounds in animal wastes and to discuss some animal recycling systems for efficient utilization. It was concluded that animal waste nitrogen is utilized when fed in livestock diets. Ruminants seem to utilize animal waste nitrogen better than other species. Caged poultry droppings appear to be the most suitable for recycling to ruminants. The author feels that technological advance will probably result in physical and fermentative advance for conversion of animal waste nitrogen into products of even higher nutritive value for livestock feeding. (Merryman-East Central).

1875 - A9 600

### AMMONIA TOXICITY LEVELS AND NITRATE TOLERANCE FOR CHANNEL CATFISH (ICTALURUS PUNCTATUS)

Caterpillar Tractor Co.
Peoria, Illinois
G. L. Knepp, and G. F. Arkin,
Presented at the 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-537, p. 2 fig, 1 tab, 7 ref.

Descriptors: *Channel catfish, *Ammonia, *Toxicity, *Bass, *Nitrates, *Fish farming, Resistance, Water pollution sources, Commercial fish, Fish management, Lethal limit, Bioassay, Filters, Filtration, Water purification, Water quality, Behavior, Fish toxins.
Identifiers: *Ictalurus punctatus, *Micropterus salmoides, LC50.

Ammonia toxicity levels and nitrate tolerance are important factors in effective channel catfish farming. The results of this investigation indicate that the LC100 value for total ammonia is 45.7 and the LC50 is 37.5 ppm. Observations of nitrate concentrations for channel catfish and large mouth bass (Micropterus salmoides) indicate tolerance as high as 400 ppm. First symptom levels, such as the concentration values of total ammonia when fish go off feed (30 ppm) are seemingly more important to closed-system fish farmers. Recovery from higher levels than this indicate tolerance for short periods of time. (Katz).

1876 - B2, D4 300

### FEASIBILITY OF OVERLAND-FLOW TREATMENT OF FEEDLOT RUNOFF

Robert S. Kerr Environmental Research Laboratory
Post Office Box 1198
Ada, Oklahoma
R. E. Thomas
Environmental Protection Agency Report No. EPA-660/274-062, December, 1974, 28 p. 1 fig, 12 tab, 8 ref.

Descriptors: *Agricultural runoff, *Feedlots, Agricultural wastes, Waste treatment, Nitrogen cycle, Phosphorus cycle, Lagoons.
Identifiers: Overland flow, Loading rates.

This report covers six months of pilot-scale experiments and six months of data collection at one field experiment. The pilot-scale studies were conducted on plots which were 6-feet by 30-feet with a 4.5 percent slope. These studies indicated that: (1) loadings of 2 to 3 inches per week were suitable for field testing, (2) the weekly load should be applied in fractional increments at daily to three times per week frequencies, and (3) instantaneous spray rates should be less than 0.10 inch per hour. The field studies covered in this report were initiated at 12,000-head capacity feedlot and utilized a four-component train for runoff collection and treatment. The treatment train included collection lagoons, a storage reservoir, the overland-flow area, and a final polishing pond. Data from the short period of operation (six months) corroborated the results of the pilot-scale study and indicated that inclusion of the final polishing pond substantially improved the overall performance. R. E. (Thomas).

1877 - B1 700

### AN EXPERIMENTAL ANALYSIS OF STRAIN AND DEFLECTION IN GRIDWORK PANELS FOR FLOOR SYSTEMS FOR LIVESTOCK

Oklahoma State University
G. L. Pratt
Ph.D. Thesis, Department of Agricultural Engineering, Oklahoma State University, Stillwater, 1967, 167 p. 37 fig, 39 tab, 23 ref.

Descriptors: *Livestock, *Design procedures, *Equations.
Identifiers: *Gridwork system, *Perforated floors.

The problem considered in the investigation was the evaluation of design procedures to be used for a gridwork system suitable for perforated floors for livestock. The objectives of the work were to determine if a prediction equation could be developed from data collected in a series of tests using grid models; and to validate existing design procedures by using the prediction equations that might be developed. Design data was given in detail. It was found that prediction equations gave useful information in developing or validating design. (Cartmell-East Central)

1878 - B1, E2 300

### MAINE GUIDELINES FOR MANURE AND MANURE SLUDGE DISPOSAL ON LAND

Miscellaneous Report 142, The Life Sciences and Agricultural Experiment Station and the Cooperative Extension Service, University of Maine, Orono, 1972, 21 p. 2 fig. 11 tab.

Descriptors: *Manure, *Sludge, *Maine, Nitrogen, Lagoons, Irrigation, Landfills.
Identifiers: *Land spreading, Composting, Guidelines.

This standard is concerned with conditions for: (1) total recycling of nutrients through planned crop production; (2) disposing of excess manure on the land by spreading; (3) piling on the land; (4) bulk burying in landfill; (5) composting; (6) lagoon treatment with sludge and liquid disposal; (7) disposal by irrigation; and (8) dehydrated manure disposal. Maximum rate for spreading manure on land and for other methods were developed from the physical and chemical characteristics of each individual soil, and from the available knowledge of the movement of manure liquids and residues on and through each soil type. The limiting factor in determining application rate is the pounds of nitrogen per acre to be applied. An extensive table is given summarizing the permissable disposal practices and maximum manure application rates for several Maine soils. (McQuitty, Barber-University of Alberta).

1879 - A2, B2, E2 300

### THE STOCKMAN'S ROLE IN WATER POLLUTION CONTROL

Agricultural Engineer
Cooperative Extension Service
Washington State University
E. H, Davis and H. A. Bunten.
Extension Circular 361, Washington State University, Pullman, August, 1970, 6 p. 18 fig.

Descriptors: *Water pollution control, *Legal aspects, Feedlots, Agricultural runoff, Lagoons Fertilizers.
Identifiers: Land spreading.

Animals should be fenced away from streams or waterways. Runoff from feedlot surfaces and feed storage areas should be kept out of streams by dikes, culverts or other such diversion facilities. If lagoons are to be used to impound animal wastes, they should be lined with an impervious material to prevent seepage of effluent and should be protected with dikes in the event of floods. Equipment for applying animal wastes to fields was described. (McQuitty, Barber-University of Alberta).

1880 - A4, B1 600

### EFFECTS OF AGRICULTURAL PRACTICES ON AQUIFERS

Department of Biological and Agricultural Engineering
North Carolina State University
Raleigh
G. J. Kriz
Presented at the 1971 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 7-10, 1971, 18 p. 88 ref.

Descriptors: *Aquifers, *Effects, *Animal wastes,, Fertilizers, Pesticides, Bacteria, Viruses, Soils, Climates, Topography, Nitrates.
Identifiers: *Agricultural practices, *Groundwater pollution, Saline waste waters.

Literature published since 1969 is reviewed which concerns the effects of agricultural practices on aquifiers. One section is devoted specifically to animal wastes. On the basis of published research, it is reported that nitrate levels beneath feedlots usually decline markedly with depth, probably as a result of denitrification and the effect on infiltration of a manure packed cover. Some type of pollution is probably occurring beneath feedlots but how fast the pollutants are moving to the water table and how far they move in aquifers is not generally known. (McQuitty, Barber-University of Alberta).

1881 - B2, D4, E2 300

### A RECIRCULATING WASTE SYSTEM FOR SWINE UNITS

Department of Agricultural Engineering
Iowa State University
Ames, Iowa
J. R. Miner
Environmental Protection Agency Report EPA-670/2-73-025, July, 1973, 220 p. 41 fig, 118 tab, 88 ref.

Descriptors: *Swine, *Waste treatment, Ditch Lagoons, Biochemical oxygen demand, Waste water, Soil water percolation, Effluents, Drain tiles, Ammonia.
Identifiers: Swine wastes, *Oxidation ditch, *Irrigation disposal, *Solid waste management, Reuse, Chemical oxygen demand, Solids reduction, Manure hauling, Ditch pump, Flush tanks, Soil preparation.

The purpose of this project was to develop and characterize a swine manure management system. The goal of the system was to collect, transport, treat, reuse and dispose of the manure in such a way that it would be compatible with current confinement swine production systems, yet minimize both labor and pollution potential. Such a system was devised and evaluated. Its basis was to hydraulically flush manure from shallow dunging gutters with the treated wastewater. The treatment devices evaluated included an anaerobic lagoon and an oxidation ditch. Excess water from the system was applied under controlled observation to adjacent cropland using conventional sprinkler irrigation equipment. The overall validity of this concept was proven. (Miner).

1882 - A1, B3, E2 300

### RELATING AGRICULTURAL INSTRUCTION TO ENVIRONMENT IMPROVEMENT: THE ROLE OF LAND AND SOIL

Agricultural Chemistry and Soils Department
Arizona University
Tucson
W. H. Fuller
Journal Paper No, 1854 of the Arizona Agricultural Experiment Station, University of Arizona, 1971, p. 69-72. 4 fig, 1 ref.

Descriptors: *Soils, *Waste disposal, *Oceans, *Water pollution, *Soil contamination, Fertilizers, Soil conservation, Organic matter, Carbon dioxide, Bacteria, Nutrients, Municipal wastes, Nitrogen, Phosphorus, Sulfur, Farm wastes.
Identifiers: *Agricultural instruction, *Land disposal, *Manure, Transformation.

For many years people have warned the government and other people that man's waste disposal problem should be controlled before it gets out of hand. In the past these warnings were ignored, but today many people are waking up and working to slow down the pollution of our environment. Pollution usually ends up in either the soil or ocean. Resistance to polluting the ocean has thrown most of the burden of waste disposal on the soil. Pollution can be controlled through the soil because it is an excellent digester of wastes. The soil decomposes organic matter. It produces nitrogen and sulfur through complex microbial cycles which are initiated by organic material, and the end product of most waste is carbon dioxide, water, and humus. What is needed is knowledge of how to use these wastes to benefit the soil, and this should begin in the colleges. Courses should be developed to make people aware of the problems and the solutions. (Russell-East Central).

1883 - B2, E2 400

### CUSTOM CATTLE FEEDING MOVES TO THE SOUTHEAST

B. Johnson
Progressive Farmer, Vol. 89, No. 4, p. 96, April, 1974, 1 fig.

Descriptors: *Cattle, *Southeast U.S., *Waste disposal, Costs, Feedlots.
Identifiers: Feeding, Land disposal

Custom cattle feeding in the Southeast, concrete feedlot flush system, and reconstituted high-moisture corn are a few of the special features of the new Walworth Farms Feedlot in Eutawville, South Carolina. To solve the high rainfall and mud problems, Walworth has installed a flush system made by AGPRO, Inc., to remove manure daily. All 40 lots are paved with concrete and can be flushed by pumping water into a reservoir and releasing it to run across the pens. After this water flushes the lots, it then goes into a large holding tank from which it is pumped onto the land to be used for growing silage. (Cameron-East Central).

1884 - A1, B2, D4, E2 400

### THE COWS VS. THE SUBURBS

College of Engineering
Washington State University
Pullman
D. C. Flaherty
Quest, Vol. 6, No. 1, p. 1-7, March, 1968. 10 fig.

Descriptors: *Dairy industry, Costs, Research and Development, Water pollution, Social aspects, Lagoons, Grants.
Identifiers: Land spreading.

The problem of cow-suburb co-existence, although common in many parts of the United States, is becoming especially acute in certain areas of western Washington. Not only is there an aesthetic problem, but even more critical is the potential water pollution problem. To prove the belief that cows and surburbs can exist together, an extensive research project was begun last May with Dr. Donald E. Proctor, a Research Division sanitary engineer, as the chief investigator. The study is primarily being carried out at the Monroe Reformatory Honor Dairy Farm. Because of flooding problems, Dr. Proctor asked for a Solid Waste Disposal Demonstration Grant. It is anticipated that after the end of the three-year study, the Monroe project facilities will remain in operation. The project facilities will continue to be available for inspection by anyone interested in dairy management. Also, all operating data and evaluation reports will be available for study by interested individuals or agencies. (Cameron-East Central).

1885 - B1, D1, E3 400

### CALIFORNIA ISSUES DPW REGULATIONS

Poultry Digest, Vol. 33, No. 387, p. 197, May 1974.

Descriptors: *Regulation
Identifiers: *Dried animal wastes, License, Processing, Requirements, California Department of Food and Agriculture.

On April 10, 1974, the California Department of Food and Agriculture released proposed licensing and processing requirements for dried animal wastes products within the state. Anyone producing dried animal waste products must have a commercial feed license. The applicant must submit a description of the facilities equipment and processing procedures. If satisfied, the Department director will issue an endorsement to the commercial feed license. The director may require use of recording devices, thermometers, periodic sampling and laboratory examination, and such other records as he may deem necessary. Under the general provisions, dried animal wastes are defined as a processed product composed of total excreta—with or without litter from poultry or ruminant animals. The final product cannot exceed 12 percent moisture and must be free of pesticides and drug residues and also free of pathogens. The product shall not be fed for 15 days prior to slaughter. Specific animal waste products—dried poultry waste, dried poultry litter, and dried ruminant waste—are described. (Cameron-East Central)

1886 - A5, A8, B1 600

### SLOTTED-FLOOR COLD-CONFINEMENT BEEF CATTLE HOUSING

Agricultural Engineering Department
Illinois University
Urbana—Champaign
D. G. Jedele and F. W. Andrew
Presented at the Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, 18 p. 22 fig, 1 tab.

Descriptors: *Cattle, *Design, Performance.
Identifiers: *Slotted floors, *Cold confinement, *Housing, Waste management.

Slotted-floor cold-confinement systems for finishing feeder cattle have one side open except for a fence which keeps the cattle inside. Inside temperature fluctuates according to outside temperature. No bedding is used. Manure falls through the slotted floor to the storage tank below. Nine advantages of such a system are: (1) Surface runoff is practically eliminated, (2) Slotted floors eliminate the cost of bedding and the labor for spreading value. (3) Protection from sun and rain maintains the fertilizer value. (4) Less labor is needed to handle manure, (5) Flies are reduced. (6) Cattle are more docile and easier to handle when sorted or treated. (7) Cattle are usually clean and seem to be favored by packers because of a 1 to 2 percent better yield. (8) The herdsman can do a better job of observing cattle, especially during bad weather. (9) Less land is needed, and the site development is easier. Design recommendations are given. (Merryman-East Central)

1887 - A1, B1, E2 400

### ALL OF A SUDDEN MANURE DOESN'T SMELL SO BAD ANYMORE

Extension Agronomist
Pennslyvania State University
W. W. Hinish
Crops and Soils Magazine, Vol. 277, No. 3, p. 12-15, December, 1974. 3 fig, 1 tab.

Descriptors: *Animal wastes, *Fertilizers, *Nutrients.
Identifiers: Land disposal, Application rates.

Animal wastes are once more being considered as fertilizers because of the rising cost and scarcity of commercial fertilizers. The nutrient value of farm wastes is high. They contain primarily nitrogen, phosphorus and potassium. Half the nitrogen and two thirds of the potassium is in liquid form. Almost all the phosphorus is in solid form, Improper storage and leaching can result in losses of the liquid nutrients. Proper handling such as application at low rates just before plowing increase the nutrient benefits. Nutrients in the solid form must decompose. Therefore, about half the nitrogen content of cattle and swine wastes is not considered available the year of application. But all the nitrogen of poultry wastes is considered available the year it is applied. (Kehl-East Central)

1888 - A1, B2, E2 600

### BEEF FEEDLOT MANURE AND SOIL WATER MOVEMENT

Associate Professor
Agricultural Engineering Department
Kansas State University
Manhattan
H. L. Manges, D. E. Eisenhauer, R. D. Stritzke, E. H. Goering.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 10 p. 1 fig, 1 tab, 5 ref.

Descriptors: *Equations, Soils, Feedlots.
Identifiers: *Manure, *Water intaake rates, *Application rates.

Feedlot manure from the 33,000 head capacity Pratt Feedlot, Inc., located 10 kilometers north of Pratt, Kansas, was applied to Farnum loam soil annually at rates ranging from 0 to 977 metric tons dry matter per hectare to determine the effects of feedlot manure application rates on the basic water intake rate, Feedlot manure was also applied to another area at rates ranging from 0 to 589 metric tons of dry matter per hectare. This area received no manure in subsequent years. Multiple regression equations were developed to predict basic intake rates from annual application rates. Basic intake rate gradually decreased as manure application rate increased during the first year. During subsequent years, basic intake rate increased as manure application rate increased up to 93 to 269 metric tons dry matter per hectare annually and decreased as manure application rate continued to increase. (Battles-East Central)

1889 - A1, B1, E2 300

## AGRICULTURAL ANIMALS AND THE ENVIRONMENT

Illinois College
Jacksonville
R. Graber
Feedlot Waste Management Regional Extension Project, Oklahoma State University, Stillwater, July, 1974, 55 p. 17 fig, 6 tab, 39 ref.

Descriptors: *Feedlots, Management, Air pollution, Water pollution, Groundwater pollution, Anaerobic treatment, Lagoons, Fertilizers, Climatology, Agricultural runoff, Costs.

A demand for animal products and meats has resulted in a concentration of animals in confined areas. Animal wastes, a by-product of the meat industry, cause undesirable environmental modifications. Such modifications can be minimized by proper management practices and site selection. Although groundwater appears to be relatively unaffected by active feedlots, surface waters need to be protected. The soil used for feed production to run the feedlot is capable of safely assimilating the animal wastes produced by the lot. Feedlot odor production is a function of both management and climate. Gas dispersion is dependent primarily on wind speed and mixing height. Economic parameters favor the location of large facilities in the same general area where climatic conditions are most favorable. (Kehl-East Central)

1890 - B2, D1 700

## LABORATORY STUDIES ON FEEDLOT RUNOFF

Department of Civil Engineering
Nebraska University
L. R. Christensen
MS Thesis, Department of Civil Engineering, Nebraska University, April, 1973, 77 p. 16 fig, 15 tab, 40 ref.

Descriptors: Animal wastes, Agricultural runoff, Feedlot runoff, Waste treatment, Feedlot wastes, Coagulation.

Laboratory studies, beginning in mid-September, 1971, and continuing through the summer of 1972, were made to determine the optimum operating conditions for an extended aeration system with air lift solids return. Treatment efficiencies were evaluated at relative equilibria of the monitoring parameters of MLSS, effluent SS, mixed liquor COD, effluent COD, and soluable effluent COD with respect to the influent waste COD and SS. Results of the study showed that aerobic treatment with a forced solids return could operate at greater than 50 percent efficiency for both solids and COD removal at detention times as low as 2 days without additional treatment. It was concluded that feedlot runoff is amenable to aerobic treatment. (Cameron-East Central)

1891 - A1, B2, D4, E2 300

## WASTE TREATMENT SYSTEM FOR CONFINED HOG RAISING OPERATIONS

Midwest Research Institute
Kansas City, Missouri
W. E. Park
Environmental Protection Agency Report No. EPA-660/2-74-047, May, 1974, 73 p. 34 fig, 4 tab.

Descriptors: Swine, Waste treatment, Aeration, Settling pond.
Identifiers: Odor control, Economics, Surface aerators, Flushing gutters, Aerobic digestion.

A waste treatment system was installed in conjunction with an existing confined swine feeding operation at Schuster Farms, Gower, Missouri. The system consisted of a concrete aeration tank equipped with mechanical surface aerators, followed by a settling pond. Wastes from the 1,000-hog feeding operation were flushed through a gutter in the concrete feeding floor into the aeration tank, where they were aerobically digested. All aeration tank discharges were retained in the settling pond where the liquids evaporated. The waste treatment facility operated continuously and dependably over a 2-year period, with treatment efficiency averaging 90 percent to 95 percent. The system effectively controlled objectionable odors and insects, contained all liquid runoff emanating from the feeding operation, and left only a dry, inert residue suitable for land disposal. Installation cost for the system was $12,000. Net operating costs, including amortization of capital costs, were $7.33 per day. Thus, total environmental control was achieved at a cost of approximately $1.00 per hog, or 1/2 cent per pound (1.1 cent per kilogram) of weight gained while on the feeding floor. (Water Resources Scientific Information Center)

1892 - A1, B1 600

## IMPLEMENTING THE MISSOURI APPROACH TO SWINE WASTE MANAGEMENT IN NORTHEAST MISSOURI

Area Agricultural Engineering Specialist
Kahoka, Missouri
J. A. Hoehne and R. M. George
Presented at 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, 1973, 4 p. 1 ref.

Descriptors: *Design, *Missouri, *Confinement pens, *Pollution abatement, Evaluation, Agricultural runoff.
Identifiers: Waste management, *Swine, *Storage basins, *Anaerobic lagoons, *Soil-plant filters, Missouri Approach, Slotted floors.

The design and implementation of animal waste management systems using the basic concepts set forth in the "Missouri Approach" to Animal Waste Management is reviewed. The basic components of swine waste management systems in Northeast Missouri are concrete detention basins, anaerobic lagoons, and soil-plant filters. The waste management systems formed by combinations of these components are evaluated. The design, implementation and management of these waste management systems appear to have many practical applications. (Cartmell-East Central)

1893 - A1, E2 600

## LAND DISPOSAL OF POULTRY MANURE IN RELATION TO SOIL WATER QUALITY AND SILAGE CORN YIELD

Connecticut University
Storrs
R. W. Wengel and J. J. Kolega
Presented at the 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, December 11-15, 1972, 31 p. 2 fig, 16 tab, 7 ref.

Descriptors: *Poultry, *Water quality, *Lysimeters, Nitrates, Chlorides, Soil microorganisms.
Identifiers: *Land disposal, *Yields, Application rates.

A field lysimeter study was conducted concerning the effects of high poultry manure application rates on corn silage production as it relates to crop and soil water quality. The findings indicated that for normal soil conditions, the soil was effectively filtering out microorganisms for the two and one-half foot depth. In general nitrate and chloride concentration in all lysimeters were high during those years when manure was applied. The high rate of application resulted in higher concentrations of nitrate and chloride. The soil water coming from the manured plots had a greater degree of acidity. The average COD concentrations of the soil water for any drain was less than 100 mg/1. Crop yields were inversely related to manure application rates. Of the measurements made, the nitrate ion is the most critical parameter in establishing the maximum application rates for manure. (Cartmell-East Central)

1894 - B1 100

## HEAT AND MOISTURE PRODUCTION FROM A BEEF BUILDING INCLUDING MANURE TANKS

Confinement Engineer
Morton Buildings
Spencer, Iowa
M. A. Hellickson, H. G. Young and W. B. Witmer
Transactions of the ASAE, Vol. 17, No. 3, p. 533-535, May-June, 1974, 4 fig, 5 ref.

Descriptors: *Design, *Heat, *Moisture, *Storage tanks, *Sensible heat, *Latent heat, *Cattle.
Identifiers: *Confinement building.

A study was established in order to determine (1) total heat and moisture production from a closed confinement beef building under actual production conditions, (2) sensible and latent heat production from a closed confinement beef building, and (3) heat and moisture contributions to the environment from the manure storage tank located under the slotted floor. These data are essential for proper design of livestock structures and environmental control systems. The following data were collected. Average daily total, sensible, and latent heat production from a building housing 62 head of 530 to 640-lb. Hereford steers averaged 2870, and 2130 Btu per hr. per head, respectively. The effect of the manure storage tank located under the slotted floors was to add an average of 205 Btu per hr. per head of latent heat and the remove 175 Btu per hr. per head of sensible heat from the animal environment. It was determined that latent heat production in a confinement beef building decreases with increases of relative humidity and animal density. Latent heat increases with increasing temperature. Sensible heat, however, decreases with temperature increase and increases with relative humidity increase. (Cartmell-East Central)

1895 - A1, B1, E2 200

## AGRICULTURAL WASTES AND GROUND WATER QUALITY

California University
Davis
R. S. Ayers
Proceedings of 9th Biennial Conference on Ground water, September 13-14, 1973, Francisco Torres Conference Center, Goleta, California; California University Water Resources Center Report No. 28, p. 94-96, December, 1973.

Descriptors: *Water pollution sources, *Farm wastes, *California, Leaching, Fertilizers Groundwater, Water pollution control.

Irrigated agriculture's waste products include salts concentrated by evapotranspiration, residues of fertilizers and soil amendments not picked up by crops, and animal manures from dairy and feed lots. The contamination can be minimized by establishing a favorable balance where export of pollutants balances import, and at a sufficiently low level of pollutant that beneficial uses are not affected. (Knapp-USGS)

1896 - A1, F3 600

## WATER QUALITY AND WASTE DISPOSAL IN MONTANA

Department of Botany and Microbiology,
Montana State University
Bozeman
J. W. Jutila
Montana Agriculture — Focus on Improving the Environment, December 3-4, 1970, p. 61-68, 1 fig, 2 tab.

Descriptors: *Water quality, *Waste disposal, *Montana, *Water pollution, *Eutrophication, Nitrates, Phosphates.

Many Montana rivers and streams are being polluted with human and agricultural wastes.

even at their headwaters, to the extent that the quality of water of the Missouri River along its entire length may be seriously compromised. Surface waters are becoming so fertilized by man's activities that objectionable growths of water flora appear in abundance. In 1957, several teams of investigators from the Montana State University investigated the nature of the pollution problem in the East Gallatin River and its tributaries. Phosphates and nitrates coming from sanitary sewer systems, synthetic detergents, burial of solid wastes, and excreta of farm animals, were found to be the primary factors causing undesirable water changes. Federal and state agencies have sponsored studies on the problem and solution of agricultural and human waste disposal pollution, emphasizing water quality studies. But far more research is required on the identity, fate, and biological and non-biological transformation of these pollutants. (Hisle-East Central)

## 1897 - A1, B1, D1, E2 300

### CHICKEN MANURE, ITS PRODUCTION, VALUE, PRESERVATION, AND DISPOSITION

C. F. Eno

Agricultural Experiment Station Institute of Food and Agricultural Science, Circular S-140, University of Florida, Gainesville, May, 1962. 18 p. 5 tab. 8 ref.

Descriptors: *Poultry, *Chemical properties, *Nutrients, *Preservation, *Disinfection, *Waste disposal, Dehydration, Leaching, Economics.
Identifiers: *Manure, Composting.

Poultry waste is a good source of plant nutrients. Factors affecting poultry waste production rates are age, breed of chickens, and amount and kind of feed and water consumption. Poultry waste contains such major fertilizer constituents as nitrogen (N), phosphorus (P205) and potassium (K20). Since the vast majority of poultry waste is not used as produced, aging causes many compositional changes. Poultry waste composition is also influenced by the kind and amount of litter. Nutrient availability is related to the form in which the elements occur. Fresh poultry waste may contain nutrients in both organic and inorganic form. In many older accumulations, leaching of inorganic fractions results in a low nutrient content and low availability. Leaching of soluble compounds (primarily salts) and volatilization are the primary routes by which nutrients are lost. Methods of preservation and disinfection are given. Methods of poultry waste disposal and management are also discussed. (Kohl-East Central)

## 1898 - A1, B2, D3, D4, E1 400

### ANIMAL WASTE DISPOSAL

Feedstuffs, Vol. 43, August, 1971, p. [illegible]

Descriptors: *Animal wastes, *Waste disposal, *Canada, Aerobic treatment, Lagoons, [illegible] Effluent.
Identifiers: Anaerobic treatment.

The National Hog Center discharges animal waste into the Fraser River in British Columbia. A University of British Columbia team reported that the National Hog Center is [illegible]

## 1899 - A4, B1, E2 400

### NITROGEN LOAD OF SOIL IN GROUND WATER FROM DAIRY MANURE

Department of Soil Science and Agricultural Engineering

California University
Riverside
D. C. Adriano, P. F. Pratt, S. E. Bishop, W. Brock, J. C. Oliver and W. Fairbank
California Agriculture, Vol. 25, No. 12, p. 12, December, 1971. 4 fig.

Descriptors: *Nitrogen compounds, *Dairy industry, *Salts, *Sampling.
Identifiers: *Land disposal, *Application rates, *Groundwater pollution, *Soil contamination.

Nine sites for each of the following categories were drilled with power driven augers in the Chino-Corona dairy area of California: (a) two sites with no manure or irrigation water applied, (b) six acres of irrigated cropland for disposal of barnyard and/or liquid manure, (c) five irrigated pasture sites for disposal of wastes from milking operations, and (d) two corral sites where manures were generally scraped twice yearly and discharged to croplands and pastures. Samples were collected and analyzed for ammonium-nitrogen (NH-N), nitrate-nitrogen (NO2-N), and nitrate-nitrogen (NO3-N). Water from the water tables was sampled for NO3 and total salt analysis. Comparison was made of water from adjacent domestic wells. NO3-N concentration was highest under the corrals, followed by the pastures, then the croplands, and then the controls. While NO3 concentrations in deep wells were considerably lower than those of shallow wells, the NO3 concentrations of deep wells exceeded the PHS standard of 45 parts per million NO3. Thus dairy manure disposal to croplands and pastures is hazardous to ground water. If high rates of manure disposal are to continue in this area, research is needed on: (1) recycling nitrogen and other nutrients under local conditions in order to establish application rates, (2) removing salts and nitrogen so that disposal amount can be increased, and (3) development of alternatives to land disposal of manure. (Merryman-East Central)

## 1900 - B1, D1, E3 300

### CONVERSION OF CATTLE FEEDLOT WASTES TO AMMONIA SYNTHESIS GAS

Texas Tech University, Lubbock [illegible]
J. E. Halligan, K. L. Herzog, H. W. Parker, and R. M. Sweazy
Environmental Protection Agency Report No. [illegible], December, [illegible] p. 7 fig. 5 tab. [illegible] ref.

Descriptors: *Cattle, *Feedlots, Gases, Equipment.
Identifiers: *Fluidized bed reactor, Anhydrous ammonia, Synthesis gas.

A study was undertaken to determine the potential of a process to convert cattle feedlot manure to anhydrous ammonia. Due to the fact that ammonia is currently produced on a large scale using natural gas and air, only the processing associated with a reactor system to convert the manure into a suitable synthesis gas was considered in this study. The synthesis gas can be further processed to anhydrous ammonia using existing technology. (Halligan-Texas Tech)

## 1901 - A1, E2, E3 600

### FACTORS WHICH INFLUENCE THE UTILIZATION OF ANIMAL EXCRETA EITHER DIRECTLY BY ANIMALS OR INDIRECTLY THROUGH PLANTS

[illegible]

Descriptors: *Recycling, *Hydroponics.
Identifiers: *Manure, *Land disposal, *Refeeding.

A literature review of potential recycling [illegible] (1) recycling into the crop production system by field application of manure; (2) recycling of manure by hydroponic growth of algae, bacteria, yeast, cereals, and/or grasses; and (3) recycling by direct refeeding of manure to animals. The author concluded that hydroponics and integrated cropping systems are efficient methods for utilization of manure. Direct recycling of poultry manure through ruminants may have potential worth developing. (McQuitty, Barber-University of Alberta)

## 1902 - B3, C5, D4 100

### WINTER HIGH RATE COMPOSTING OF BROILER MANURE

Department of Environmental Biology
Guelph University
Guelph, Ontario
R. G. Bell and J. Poe.
Canadian Agricultural Engineering, Vol. 13, No. 2, p. 60-64, December, 1971. 10 fig. 2 tab. 5 ref.

Descriptors: *Winter, Aerobic conditions, Carbon, Nitrogen.
Identifiers: *Broilers, *Manure, *Composting.

A high-rate composter consisting of a reinforced concrete horizontal silo with an air distribution system incorporated into the floor was tested in Ontario in January. Freezing rain, sub-zero temperatures which required removal of frozen compost from the walls with chisels and crowbars and rodents which were "using the lower reaches of the composter as a 'centrally heated' home" caused difficulties. It was concluded, however, that (1) broiler manure can be composted outdoors in a Canadian winter without auxiliary heat, (2) a forced aeration system is essential for high-rate composting of broiler manure, (3) loading should be daily (seven days per week), (4) the composter should be roofed to avoid excessive wetting of the contents by rain, and (5) the addition of a blending material, preferably ground garbage, to raise the carbon-to-nitrogen ratio well above its value of 14.3 for broiler manure would be advantageous. (Whetstone, Parker, Wells.-Texas Tech University)

## 1903 - B1, E3 300

### FEEDING VALUE OF ANIMAL WASTES

Animal Science Research Division
USDA, ARS
Beltsville, Maryland
L. W. Smith
Animal Waste Reuse—Nutritive Value and Potential Problems from Feed Additives—A Review, ARS 44-224, February 1971, p. 8-15, 1 tab.

Descriptors: *Feeds, *Ruminants, Algae, Cattle, Poultry, Hogs, Animal diseases, [illegible], Waste treatment, Dehydration, Feasibility.
Identifiers: *Manure, *Literature review, Feeding value.

This paper reviews the literature concerned with feeding animal wastes to livestock. [illegible]

## 1904 - A3, A6, B1 100

### ODORS AND GASES LIBERATED FROM DILUTED AND UNDILUTED CHICKEN MANURE

Cornell University
Ithaca, New York
D. C. Ludington, A. T. Sobel, and A. G. Hashimoto.
Transactions of the American Society of Agricultural Engineers, Vol. 14, No. 5, p. 855-859, September-October, 1971. 12 fig. 1 tab. 8 ref.

Descriptors: *Odor, *Gases, Poultry, Ammonia, Carbon dioxide, Hydrogen Sulfide.
Identifiers: *Manure, *Dilution

Investigation and comparison of the release of some gases and odors from stored chicken manure in both undiluted and diluted states is reported. Air was passed over the surface of manure in two containers, one for each system, at a flow rate of 1 standard cu. ft. per hr. This rate was checked daily with a wet-test meter. Container outlets were connected to a manifold from which the air was distributed to the carbon dioxide analyzer, to wet scrubbers for ammonia and hydrogen sulfide analyses, or to odor-strength measuring devices. White Leghorn laying hens provided the manure, which was added daily. Results of the study indicate that, with regard to production and release of gases and odors, significant differences occurred between undiluted and diluted manure. Undiluted manure released slightly greater amounts of carbon dioxide than diluted manure; the undiluted system likewise released more ammonia. Manure stored in a diluted state produced more hydrogen sulfide and ammonia than undiluted-state manure. Although both releases were below threshold, hydrogen sulfide release from the diluted system was twice that released from undiluted manure. Odor strength of animal manures can be measured by liquid dilution on a laboratory basis; odor strength of released gases can be measured by vapor-dilution methods. Diluted or "liquid" manure produces odors with a strength comparable to odors arising from undiluted manure. The quality of "liquid" manure odor is much more offensive than the ammonia odor from the undiluted system. [illegible]

## 1905 - B1, C5, D4 100

### AEROBIC TREATMENT OF PIGGERY WASTE

School of Biological Sciences, University Sains Malaysia, Penang, Malaysia
J. D. Owens, M. S. Evans, F. E. Thacker, R. Hissett, and S. Baines
Water Research, Vol. 7, No. 12, p. 1745-1766, December, 1973. 11 fig. 7 tab. 15 ref.

Descriptors: *Aerobic treatment, Effluents, Suspended solids, Nitrification, Biochemical Oxygen demand, Sludge, Acidity, Alkalinity, Degradation.
Identifiers: *Swine

Two main types of aerobic treatment systems operated at different loading rates and temperatures were studied: one with the formation and gravity separation of liquid and solid effluents, and a second without the formation or separation of the effluent into liquid and solid fractions. [illegible] loading rates, operation at 25° C appeared to increase the amount of degradation compared with that achieved at 15° C.

## 1906 - B1, D4, E3 400

### PROCESSED MANURE SEEN AS PROTEIN OF FUTURE

Beef, Vol. 11, No. 1, p. 45, September, 1974

Descriptors: *Cattle, *Refeeding, Proteins, Costs, Performance
Identifiers: *Excreta

Protein from cattle excreta can be nutritionally beneficial in supplementing feedlot rations prior to the final month or two of finishing. The benefit from the protein in the excreta was seen in increased weight gains. Lower feed costs of gain is a favorable aspect of excreta-fed cattle when no charge is made for the excreta and processing of it through a silo. R. L. Vetter, animal scientist at Iowa State University, and his colleague, Wise Burroughs, found that as much as 30 percent of cattle excreta can be successfully recycled through feedlot cattle except for the final month or two prior to marketing. The scientists say more research is needed before results obtained in experiments thus far can be recommended in cattle feeding practice. (Cameron-East Central)

## 1907 - B1, D1, E3 300

### FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES: II. PROCESS DESCRIPTIONS

Department of Chemical Engineering
Kansas State University
Manhattan
W. P. Walawender, L. T. Fan, C. R. Engler, and L. E. Erickson
Project Report No. 41, Department of Chemical Engineering, Kansas Agricultural Experiment Station, Manhattan, March 1, 1973. [illegible]

Descriptors: *Feedlots, *Energy, Design, Oil, Gases
Identifiers: *Manure, *Agricultural wastes, *Liquefaction, *Gasification, Hydrogasification

This report provides a description of three potential chemical processing schemes for the conversion of feedlot wastes to useful products. [illegible] (Walawender-Kansas State University)

## 1908 - A1, B1, D4 200

### A STATUS REPORT ON AGRICULTURAL AND MUNICIPAL WASTE TREATMENT LAGOONS IN MISSISSIPPI

Department of Agricultural and Biological Engineering
Mississippi Agricultural and Forestry Experiment Station
[illegible]

Descriptors: *Municipal wastes, *Waste treatment, *Lagoons, *Mississippi, Effluent
Identifiers: *Agricultural wastes, *Status report, Bacteriological analysis, Chemical analysis

Results are given of a study to evaluate the current use of, and attitudes toward, lagoons as devices for waste treatment. It was reported that, at the time of a State survey, there were 216 municipal lagoon systems, covering 2,072.5 acres, and 241 animal waste treatment lagoons, of which 221 were used for swine, 16 for dairy, and 4 for poultry. The BOD of the municipal lagoon effluent varied from 18.0 to 79.5 mg/1 compared to a range of BOD from 98 to 870 mg/1 for agricultural waste treatment lagoons. Agricultural waste treatment lagoons have been readily accepted by farmers and the number of lagoons is expected to increase rapidly, partially because the federal government will cover 80 percent of the construction cost. (McQuitty, Barber-University of Alberta)

## 1909 - B2, D4, E3 400

### COOKING WITH COW POWER

Popular Mechanics, Vol. 141, No. 3, p. 73, March, 1974. 3 fig.

Descriptors: *Methane, *Anaerobic bacteria, *Cattle, *Fertilizers, *Recycling, *Waste treatment, Slurries, Natural gas.
Identifiers: *Manure.

Dick Butterworth, owner of a cattle farm at Red Key, Indiana, his son and a couple of expert consultants, built a prototype generator that converts cow manure and other waste materials into methane—natural gas—and a nitrogen-rich fertilizer. Manure is mixed with water to form a slurry. Anaerobic bacteria break down the solid matter to produce methane. The Butterworth's have used home-brewed methane to run a variety of equipment: a gas lamp, a range, a gas refrigerator, a 1949 Chevrolet engine, and a space heater. It was estimated that the manure from 30 head of cattle would provide enough gas to heat the large Butterworth farmhouse. (Cameron-East Central)

## 1910 - B2, D4, E3 100

### SALTS CONCENTRATION IN A RECYCLING AEROBIC WASTE DISPOSAL SYSTEM

[illegible]
Transactions of the American Society of Agricultural Engineers, [illegible]

Descriptors: *Salts, *Recycling, *Biodegradation, *Aerobic treatment, Poultry, Biochemical oxygen demand, Effluent, [illegible]
Identifiers: *Excreta

At the bio-engineering laboratory of the Agricultural Engineering Center at the University of Georgia, research was done to study the effects of salt concentrations on the biodegradation of poultry wastes. [illegible]

### 1911 - A1, B2, D4, E3 400

## A CLOSED SYSTEM — NEW IDEA IN POULTRY WASTE DISPOSAL

D. W. Darden
Progressive Farmer, Vol. 89, No. 11, p. 42-43, November, 1974. 2 fig.

Descriptors: *Poultry, *Recycling.
Identifiers: *Excreta, *Anaerobic pond, *Aerobic pond, *Closed system.

Specialists and engineers at the Louisiana State University Cooperative Extension Service have developed a two-lagoon system that never has to be dumped. Chicken manure is flushed from pits beneath laying pens into an anaerobic pond for treatment. The water then flows into an aerobic pond for further bacterial digestion. Water is then pumped from the aerobic pond back to the laying houses where it once again flushes the pits under the laying pens. An adaptation of the system is being successfully used by a commercial operation just outside Hammond, Louisiana. Major advantages of this system are: no fly problem, reduction of labor, better working environment, no runoff, and adaptability of the system. (Batties-East Central)

### 1912 - A1, A5, B2, C5, D4 100

## AERATION OF POULTRY WASTES FOR ODOR AND NITROGEN CONTROL

A. G. Hashimoto
Transactions of the ASAE, Vol. 17, No. 5, p. 978-982, Sept.-Oct., 1974, 6 fig, 2 tab, 9 ref.

Descriptors: *Poultry, *Aeration, *Nitrogen, *Biodegradation, *Slurries, Ammonia
Identifiers: *Odor control

This research was undertaken to study the effect of aeration rate on odor control and nitrogen removal in batch and daily fed systems. One to three day old manure from white leghorn laying hens was diluted one part manure to three parts distilled water. [illegible]

### 1913 - [illegible] 100

## EFFECT OF SLOTTED FLOORS ON AIR-FLOW CHARACTERISTICS IN A MODEL SWINE CONFINEMENT BUILDINGS

Cornell University
Ithaca, New York
[illegible]

[illegible]

A one-twelfth scale model of an existing swine confinement structure was used to determine the effects of various ventilation inlet and exhaust locations, baffle position, floor types and pit depth upon the air flow characteristics within the building. Heater thermocouple anemometer readings were recorded and analyzed statistically to determine the effects of the different treatments. Iso-velocity lines were plotted to provide visual interpretation of the regions of high and low velocities. Turbulent intensities were calculated to determine the effectiveness of air mixing. Results showed that use of baffles to direct air along the ceiling in hopes of distributing the temperature and velocity more evenly through the building tended to increase air velocity and the significance of both the floor arrangement and pit depth. Also, use of a baffled air inlet decreased the turbulent intensities within the structure, thus lessening the degree of air mixing in the ventilated space. High velocity regions near slotted floor openings appear likely to introduce malodorous and possibly toxic gases into the animal environment. The effect of slotted floors on air-flow characteristics in a model swine confinement building suggests that conventional inlet-exist location and design criteria in full scale buildings may be inadequate and may require new design standards, however, full scale validation of the results presented here should be obtained. (Solid Waste Information Retrieval System)

### 1914 - A1, B1 300

## PAUNCH MANURE AS A FEED SUPPLEMENT IN CHANNEL CATFISH FARMING

Oklahoma Cooperative Fishery Unit
BSFW
Oklahoma State University
Stillwater
R. C. Summerfelt and S. C. Yin
Environmental Protection Agency Report No. EPA-660/2-74-046, May, 1974, 114 p, 12 fig, 30 tab, 30 ref.

Descriptors: Aquaculture, Water pollution, Agriculture wastes, Abattoirs, Beef cattle, Water quality
Identifiers: Channel catfish farming, Fish farming, Fish nutrition, Paunch manure, Abattoir wastes, Recycling animal wastes, Slaughterhouse wastes, Food processing wastes.

Part A of this report examines the feasibility of using dried paunch at 10, 20 and 30 percent levels in feed for pond-rearing yearling catfish. Part B describes the effects of fish culture, using standard feeds and paunch-containing feeds, on water quality of fish ponds. [illegible]

### 1915 - [illegible]

## METHODS AND PRACTICES FOR CONTROLLING WATER POLLUTION FROM AGRICULTURAL NONPOINT SOURCES

Environmental Protection Agency Office of Water Program Operations Publications EPA-430/9-73-015, October 1973, 83 p, 18 fig, 34 ref.

Descriptors: *Water pollution control, *Farm wastes, *Sedimentation, *Nutrients, Erosion control, Pesticides, Fertilizers, Wind erosion, Soil conservation, Farm management

Potential nonpoint agricultural sources of surface and groundwater pollution include sediment, pesticides, fertilizer, and plant and animal wastes and residue from cropland, grazing acres, and farm woodlots. Sound management practices are the key to achieving acceptable water quality. Proper land use and agricultural management practices will keep soil, plant nutrients, and organic matter on land, rather than allow them to become part of the waterborne pollutant load. Erosion may be reduced by means of conservation tillage, terraces, diversions, stripcropping, contouring, grassed waterways, crop rotations, and by management. Reducing nutrient losses from agricultural operations can be accomplished by three general approaches: (1) determining the proper amount, time, and method of plant nutrient applications to ensure efficient use by plants, (2) adopting approved cultural practices, including tillage and crop rotations, and (3) reducing soil and water runoff. There are several approaches to reduce the quantity of pesticides entering surface water and groundwater. These include: controlling erosion and minimizing wind drift; reducing the quantity of pesticides used; and using biodegradable, rather than persistent pesticides. Appropriate animal and land management practices should be followed. These include: (1) spreading acceptable rates of manure uniformly on land; (2) applying feedlot runoff effluent on land as recommended for specific site conditions; (3) maintaining an adequate land-to-livestock ratio on pastures; and (4) locating feeders and waterers a reasonable distance from streams and watercourses. (Knapp-USGS)

### 1916 - C5, D1, E3 600

## COMPOSITIONAL CHANGES IN RECYCLED CHICKEN MANURE

Agricultural Research Service
United States Department of Agriculture
Northern Regional Research Laboratory
Peoria, Illinois
[illegible]
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 18 p, 7 fig, 2 tab, 18 ref.

Descriptors: *Recycling, *Poultry, Performance
Identifiers: *Refeeding, Egg production, Compositional changes

A study was undertaken to determine changes, if any, in the composition of DPW recycled at 12.5 and 25 percent levels in layer feed. [illegible]

### 1917 - [illegible]

## [illegible]

[illegible]

[illegible]

Identifiers: [illegible]

[illegible] (Cartmell-East Central)

## 1918 - B2 400
## NEW PUMP, NEW SYSTEM FOR LIQUID MANURE

[illegible]

Descriptors: [illegible]
Identifiers: [illegible]

[illegible]

## 1919 - B1, D4, E2 400
## LAGOON SYSTEM CHEAPER FOR SMALL DAIRY HERDS

[illegible]

Descriptors: [illegible]

[illegible]

## 1920 - A2, B1, D1, E1 400
## [illegible]

[illegible]

Descriptors: [illegible] Agricultural runoff, *Livestock, [illegible] farms, Research and development.
Identifiers: [illegible] ation ditch, Waste handling.

At [illegible] Industries new research and dem[illegible] under the supervision of Dr. [illegible], there is no runoff of live[illegible] into nearby ditches or creeks. Located at [illegible] City, Kansas, the farm is [illegible]ed. Oxidation ditches and aero[illegible] solve the manure handling prob[illegible]e, poultry and dairy units. The [illegible] includes a swine unit, consisting of [illegible], nursery, finishing house and [illegible]. The poultry unit has a capa[illegible] [illegible] hens in the two houses. It [illegible]y controlled and the cages are [illegible] ditch. The beef cattle unit [illegible] capacity. The 20 pens of cattle [illegible] test groups [illegible] feed formulations [illegible] of CO-OP Feed versus com[illegible]. Other facilities on the farm [illegible] mill, a stable for 6 horses, a [illegible] necropsy unit with laboratory [illegible] facilities, and a waste re[illegible] or studying new and improved [illegible] waste disposal. The work at [illegible] closely coordinated to make test [illegible] meaningful to co-op members in [illegible] and ranching (Cameron-East Central)

## 1921 - A1, B1 400
## [illegible] FEEDLOTS CAN [illegible] MORE THAN ACTIVE [illegible]

[illegible] Magazine, Vol. 27, No. 3, p. [illegible]

Descriptors: [illegible]
Identifiers: [illegible] feedlots, Nitrate concen[illegible]

[illegible] U. S. Department of Agri[illegible] [illegible] of Nebraska soil scien[illegible] [illegible] a study of the nitrate [illegible] feedlots. Under abandon[illegible] [illegible] found an average concentration [illegible] per acre in the top [illegible] [illegible] Under active feedlots, he found [illegible] acre. The make-up of the [illegible] feedlot is the reason for this [illegible] feedlots have an impenetrable [illegible] that prevents air and water [illegible] through. The nitrogen under this [illegible] a relatively immobile organic [illegible] (Cameron-East Central).

## 1922 - B1 400
## [illegible] RESULTS IN DRIER [illegible]

[illegible] Vol. [illegible]

Descriptors: [illegible]
Identifiers: [illegible] Fly control.

[illegible] in Central Georgia [illegible] (Cameron-East Central)

## 1923 - B1, D1, E3 400
## [illegible] PRODUCTION NOT [illegible] OR PRACTICAL

[illegible]

Descriptors: [illegible]
Identifiers: [illegible]

With the shortage of fuel, there is talk about producing methane from manure or crop residues. R. E. Graves, agricultural engineer at the University of Wisconsin, says this practice is not yet feasible for farmers. This gas is produced when the organic matter decays if certain conditions are just right. A special machine is needed to produce the correct conditions, which include mixing, a lack of oxygen, and a relatively constant temperature. Also, some means of collecting and storing the gas is needed. And, since the gas is explosive, certain safety precautions should be observed. The total amount of output that could be produced each day from the manure of a 100-head herd of 1,400-pound cows would only be 10 percent of what is required to operate a crop dryer for a day. (Cameron-East Central)

## 1924 - D4, E3 400
## BIOLOGICAL DIGESTION OF MANURE BY DIPTERA

Colorado State University,
B. F. Miller
Feedstuffs, Vol. 41, No. 51, p. 31-32, December, 1969, 7 tab.

Descriptors: *Manure, *Diptera, Feeds.
Identifiers: Biological digestion.

This research involved a study of cultural methods for the housefly. The adult breeder flies were housed in 2 x 8 x 5 foot cages. The flies were fed a dry mixture of skim milk, yeast and sugar. It was felt that dried skim milk might be sufficient for the adult flies. Water was provided in inverted beakers with a paper towel to soak up the water. The flies sponged this water from the moist paper towel. Manure was used as a media for deposition of fly eggs. The eggs were added to the manure at the rate of 3 grams of eggs to 4,000 grams of fresh manure. About 60 percent of the moisture in the fresh manure was lost during digestion. Preliminary work indicated that fly pupae were a good protein source for chickens. Amino acid analysis indicated that it was comparable to fish meal as a protein supplement. (Cartmell-East Central).

## 1925 - A1, B1, D1, E1 200
## SOIL CONSERVATION SERVICE TEXAS TECH UNIVERSITY WORKSHOP COMMITTEE ON FEEDLOT WASTE

United States Department of Agriculture, Soil Conservation Service.
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, [illegible] p. [illegible] fig. [illegible] tab. 7 ref.

Descriptors: *Farm wastes, *Feedlots, Water quality, Water pollution, Waste disposal, Design criteria.
Identifiers: Pollution abatement systems.

The session consisted of presentations dealing with the state laws and procedures for protecting Texas Waters from feedlot wastes. Factors that affected the feedlot wastes and the quantity and quality of such wastes were discussed. [illegible] disposal methods and designs for feed[illegible] pollution abatement systems were examined. ([illegible]-East Central).

## 1926 - A1, B1 200
## [illegible] AFFECTING QUALITY AND QUANTITY OF FEEDLOT WASTE [illegible]

Water Resources Center
Texas Tech University
Lubbock
[illegible]
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, [illegible] p.

Descriptors: *Liquid wastes, *Solid wastes, *Slurries, *Gases, *Feedlots, Slopes, Feeds.
Identifiers: Quality, Quantity, Feedlot surfacing.

Feedlot wastes occur in the liquid, solid, slurry and airborne forms. Factors that affect the pollution potential of these wastes are (1) size of cattle, (2) density of cattle, (3) slope of feedlot, (4) type of surfacing material, (5) type of ration fed, (6) climatic factors, (7) frequency of cleaning. The general way each of these affected feedlot wastes is given. (Kehl-East Central).

### 1927 - A1, B3, D4 200

## REDUCTION OF FEEDLOT WASTE BY STABILIZATION

Agricultural Engineering Department
Texas Tech University
Lubbock
W. Grub.

Descriptors: *Feedlots, *Cattle, Climatology, Population densities, Odor, Insects.
Identifiers: *Waste management, *Waste stabilization, *Composting, C/N ratio.

The organic stabilization of beef feedlot waste by composting can be done in specially designed digesters or in exposed open air piles. A biologically stable organic product can be obtained which is free from noxious odors and insect infestation. Initial physical, chemical and biological characteristics of the waste vary considerably. These characteristics vary because of differences in feed, population densities, climatic conditions and waste management during the accumulation period. The C/N ratio of the accumulated waste varies from 35 to 9 according to the above conditions. Aerobic composting requires at least 30 percent moisture content (based on wet weight). An optimum air supply rate of between 1.5 and 3 liters per minute per 100 pounds of organic material is required during the peak composting period. Stabilization time is dependent on feed type, initial waste condition and composting process management. (Kehl-East Central).

### 1928 - A1, B2, E2 200

## CROP RESPONSE TO WASTE MATERIALS FROM VARIOUS FEEDLOT COLLECTION SYSTEMS

Agronomy Department
Texas Tech University
Lubbock
E. A. Coleman.
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, 6 p. 3 tab.

Descriptors: *Crop response, *Feedlots, *Agricultural runoff, Slopes, Surfaces, Cattle.
Identifiers: Solute concentration, Solute accumulation.

Feedlot runoff for crop production allows the reuse of liquid that otherwise would evaporate into the air. Although information is still being gathered on waste materials, the present data has indicated several effects. The great variability in solute concentration is due to rainfall evaporation, feedlot surface material, feedlot slope, feed ration, age of pit or catch basin and other factors that have not yet been determined. Runoff from concrete-surfaced lots has a greater solute concentration than comparable sloped dirt-surfaced lots. There is a positive correlation between solute concentration and the slope of dirt-surfaced lots. The most susceptible period for all crops tested was found to be germination and the period immediately following. Tolerance to feedlot runoff varies greatly with the species. Finally, it was determined that the solute accumulation throughout the top 60 inches of the soil profile. (Kehl-East Central).

### 1929 - A1, B2, E2 200

## MANAGEMENT OF RUNOFF WATER IN RELATION TO FEEDLOT OPERATIONS

Soil Conservation Service
Temple, Texas
H. N. McGill
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971.

Descriptors: *Feedlots, *Agricultural runoff, *Irrigation, *Storage capacity.
Identifiers: Holding ponds.

A system of runoff retention and irrigation is generally considered to be the most practical and economical form of runoff control in Texas. Because of this, information was gathered to determine necessary size ratios of irrigated areas to feedlot areas for adequate runoff control. The study revealed that the required storage capacity varies with the ratio of irrigated area to feedlot area and the location in the state. The eastern part of the state would need a large amount of storage capacity. Considerable flexibility of operation is permitted in the western part of the state by holding ponds with the capacity to impound 25-year, 24 hour runoff from feedlots. Although feedlot runoff is not a dependable irrigation water supply, it can be used to supplement other sources. (Kehl-East Central).

### 1930 - A1, B1 200

## SEEPAGE LOSS FROM HOLDING PONDS

W. B. Moody.
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, 5 p. 3 fig.

Descriptors: Seepage control, *Permeability, Soil analysis.
Identifiers: *Holding ponds, Darcy's equation, Groundwater conditions.

Detailed calculations are given for a typical analysis of seepage losses from a proposed pond. Such losses may be estimated following an investigation of soil and bedrock characteristics and laboratory testing of the soils. Construction and protection of relatively impervious blankets are discussed. (Whetstone, Parker, Wells-Texas Tech University).

### 1931 - A4, B1 200

## EFFECT OF CATTLE FEEDLOT WASTES UPON GROUND WATER — A COMMENTARY

Geoscience Department
Texas Tech University
Lubbock
W. D. Miller
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, 5 p. 3 fig.

Descriptors: *Feedlots, *Groundwater pollution, *Seepage, *Pollutants, *Geology, Cattle.

Several categories of potential ground water pollutants are listed. These include inorganic dissolved solids, organic dissolved solids, insecticides-pesticides, insecticides and herbicides, and bacteria and bacterially derived products. Along with the effects of these potential pollutants, the feedlot geology must be considered in discussing the effects of feedlot wastes on ground water. Significant factors to be considered are surface topography, soil permeability, bedrock lithology, structure and permeability, and depth of ground water. Thus, some Texas areas are more susceptible to ground water pollution than others. In Texas, cases have been documented in the Edwards Plateau, the Gulf Cooast, and the High Plains. Further evaluation of the ground water pollution problem is needed. A study by Miller (1971) revealed that about 15-20 percent of the cattle feedlots in the Texas High Plains showed some evidence of seepage to the water table. Average nitrate, chlorides and dissolved solids concentrations are cited. (Kehl-East Central).

### 1932 - A2, B2, E2 200

## SOIL CONSERVATION SERVICE STANDARD AND SPECIFICATIONS FOR POLLUTION ABATEMENT MEASURES FOR CONFINED LIVESTOCK OR POULTRY FEEDING OPERATIONS

Soil Conservation Service
Temple, Texas
E. L. Alexander
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, 10 p. 1 tab.

Descriptors: Pollution abatement, *Confinement pens, *Livestock, *Poultry, *Regulation, *Agricultural runoff, Design criteria, Water pollution, Basins, Lagoons.
Identifiers: Site selection, Pollution control, Holding ponds, Land disposal.

Guidance and criteria applicable to practices and facilities for the diversion of uncontaminated off-site drainage and for the interception, settling, collecting and disposing of contaminated runoff from livestock or poultry feeding areas are explained. Criteria for the selection of a site and for the design of the feeding operation are given. (Kehl-East Central)

### 1933 - B1, E1, F2 200

## GUIDELINES FOR HANDLING LIQUID WASTE FROM FEEDLOTS

Texas Water Quality Board
Austin.
D. L. Pittman
Soil Conservation Service Texas Tech University Workshop Committee on Feedlot Waste, Texas Tech University, Lubbock, July 28-29, 1971, 4 p.

Descriptors: *Feedlots, *Liquid wastes, *Agricultural runoff, *Waste water disposal.
Identifiers: *Solid waste disposal, *Waste Control Order for Cattle Feeding Operations, Holding ponds.

The procedure for obtaining a Waste Control Order for Cattle Feeding Operations from the Texas Water Quality Board is given. Application evaluation is primarily based on pollution control measures for the following: (1) collection and retention of feeding area runoff water, (2) disposal of accumulated waste water, (3) groundwater protection from holding pond waste water seepage, and (4) disposal of accumulated solid waste. The process of obtaining a waste control order generally takes 3 months or longer. (Kehl-East Central).

### 1934 - A2, A4, B1 600

## KEEPING RUNOFF SAFE

Agricultural Research, Vol. 21, No. 10, p. 8, April, 1973. 1 fig.
*Agricultural runoff, *Runoff, *Feedlots, Groundwater pollution, Infiltration, Land wastes.

Continuing research is showing how and where Great Plains cattle feedlots may contribute to water pollution and is demonstrating that, with adequate control of runoff, feedlots can be acceptable neighbors. In cooperation with the Nebraska Agricultural Experiment Station, studies are being made of rainfall, runoff, temperature and evaporation as they affect nitrogen from cattle feedlots. These studies show that widespread contamination of ground water is un-filtration from the feedlot surface is improbable. The research indicates that feedlots should be designed to restrict surface runoff, which may transport heavy loads of pollutants. The amount of solids transported in runoff may be less from a feedlot than from tilled bare soil. Snowmelt runoff may transport 10-12 times the amounts of solids removed in rainfall from the same feedlot, and the COD will thus be correspondingly higher. The potential pollution hazard from a particular feedlot can be determined only by study of the watershed of which it is a part—its hydrologic characteristics and its proximity to surface water sources. (Cameron-East Central).

### 1935 - B3, C5, D3, E3 400

### BARN WASTES FOR FEED

Agricultural Research, Vol. 19, No. 7, p. 3-4, January, 1971. 3 fig.

Descriptors: Feeds, *Ruminants.
Identifiers: Barn wastes, Refeeding, *Digestibility, Chemical treatment.

Agricultural Research Service animal scientists blended barn wastes into dehydrated and pelleted rations and tested chemical treatments that make barn wastes more digestible for ruminant animals. On a dry-matter basis, daily intake tended to be highest on untreated wastes. But digestibility of dry matter was greatest for the sodium chloride treatment, followed by sodium peroxide, sodium hydroxide, and untreated in that order. The investigators project that a lower level of barn wastes than the 80 percent tested might be effective as a forage substitute. (Battles-East Central).

### 1936 - A1, B2, E2 100

### TRANSPORT RATE OF COD THROUGH A WET POROUS STRATUM — MEASUREMENT OF DIFFUSIVITY IN CATTLE MANURE SOLUTION

Chemical Engineering Department
Kansas State University
Manhattan
S. K. Choi, L. T. Fan, L. E. Erickson, and R. I. Lipper.
Transactions of the American Society of Agricultural Engineers, Vol. 14, No. 4, p. 750-755, July-August, 1971. 10 fig. 1 tab. 10 ref.

Descriptors: **Chemical oxygen demand, *Diffusivity, Water pollution, Percolation, Groundwater, Measurement, Mathematical models.
Identifiers: *Manure.

The transport rate of materials through various soil strata is important for determining pollution potential of wastewater [illegible]

### 1937 - B1, D1, E[illegible] 400

### [illegible]

[illegible]

Descriptors: *Fuels, *Gases, Energy, Feedlots.
Identifiers: *Pyrolysis, Manure volume reduction.

Fifty to sixty percent of the gases produced by "anaerobic incineration" have fuel value. The heat content of manure is stated to be: poultry 7200 Btu/lb., beef cattle 6400, swine 5500, and dairy cattle 5000. Volume reduction and the production of dry innocuous residues are other advantages of pyrolysis. (Whetstone, Parker, Wells,—Texas Tech University).

### 1938 - A5, B1 400

### SAGEBRUSH FOR ODOR CONTROL: IN THE FEED OR THE MANURE?

Feedlot Management, Vol. 14, p. 74, May, 1972.

Descriptors: *Sagebrush, *Feeds, *Performance, *Cattle, Feedlots, Taste.
Identifiers: **Odor control.

Studies at Colorado State University indicate that feeding chopped sagebrush in amounts of one or two lb./day has no effect on the cattle, but reduces manure odor. Salt in quantities of zero to four oz./day has no effect on gains. (Whetstone, Parker, Wells—Texas Tech University).

### 1939 - D4, E3, E4 400

### WASTE CONVERSION UNIT DEVELOPED

Feedlot Management, Vol. 14, p. 26, December, 1972.

Descriptors: *Feeds, *Methane, *Fermentation, *Anaerobic conditions, *Waste treatment, *Recycling.
Identifiers: *Refeeding.

"The Hamilton Standard Division of United Aircraft Corporation has developed a process that converts manure into a livestock feed product and at the same time produces sufficient methane gas to supply the heat and electricity to run the process." The process, still in the laboratory testing stage, operates in the absence of oxygen using bacteria present in the waste to accomplish fermentation. (Whetstone, Parker, Wells—Texas Tech University).

### 1940 - B1, E5 400

### WARM WATER STUDY

Feedlot Management, Vol. 14, p. 61, December, 1972.

Descriptors: *Regulation, *Feeds, Algae, Feedlots, Irrigation.
Identifiers: *Generating plant, *Warm water, *Greenhouses.

Oregon State University is studying the possibility of routing warmed water from power plants through greenhouses [illegible] (Whetstone, Parker, Wells—Texas Tech University).

### 1941 - A2, B1 400

### TOTAL WASTE MANAGEMENT SYSTEMS

[illegible]

A description is given of solid waste and runoff handling at three beef cattle feedlots in Kansas. Solid wastes are removed from all three lots by a commercial contractor. Manure can be stockpiled in the lots. When the lots are cleaned, about one inch of hardpack manure is left on the lot surface to reduce infiltration. The runoff systems involve collection and dispersion of liquids and have been designed to handle a one-time rainfall of over 6 inches. (McQuitty, Barber—University of Alberta).

### 1942 - A2, B1, E2 400

### THAT INESCAPABLE BYPRODUCT

Feedlot Management, Vol. 14, No. 5, p. 30, May, 1972.

Descriptors: *Design, *Feedlots, *Colorado.
Identifiers: *Runoff control, *Land disposal, *Manure, Retention pond.

A description is given of the runoff control facilities and solid manure handling practices at a 6,000-head feedlot in Colorado. All solid wastes are applied to 600 acres of cropland. Runoff is collected in a retention pond. (McQuitty, Barber-University of Alberta).

### 1943 - A1, B1 400

### CLEANEST FEEDLOT IN KANSAS

J. F. Blair.
Feedlot Management, Vol. 14, No. 5, p. 22, 24, 66-67, May, 1972.

Descriptors: *Kansas, *Feedlots, Agricultural runoff, Lagoons, Costs, Performance.
Identifiers: *Chemical fly control, *Cleaning.

A description is given of manure handling and sanitation methods at a 14,000-head feedlot in Kansas. Manure is scraped from the lots twice each year and spread on cropland or mounded and sold to farmers. All the pens were carefully graded during construction so that all runoff flows to the back of the pens and is carried to a lagoon. Fly control is accomplished by chemical sprays at a cost of about [illegible] for the chemical. The feedlot has not received any complaints from neighbors. (McQuitty, Barber-University of Alberta).

### 1944 - A9, E3 400

### THE DOOR'S STILL OPEN TO REFEEDING CATTLE WASTE

Feedlot Management, Vol. 14, No. 5, p. 48, May, 1972.

Descriptors: *Cattle, *Regulation, *Proteins.
Identifiers: *Refeeding, *Manure.

The present stand of the U.S. Food & Drug Administration on the refeeding of animal wastes is discussed. [illegible] (McQuitty, Barber-University of Alberta).

### 1945 - C3, D1, E3 400

### THIS PLANT WILL CONVERT WASTE INTO PROTEIN

[illegible]

[illegible]

A description is given of a new system for conversion of animal wastes into a high-protein supplement. Shredded manure is mixed with water to produce a slurry. Fibrous material is separated from the slurry and flows through a series of fermentation tanks in which thermophilic bacteria convert the cellulose, hemicellulose and lignin to usable protein. The soluble portion of the slurry is fermented for less time. All digested material is passed through a vacuum filter where water is removed and reused. The protein is further dried and is used as a feed supplement. (McQuitty, Barber-University of Alberta).

## 1946 - B1, D1, E3, E4, F1 400

## RECOVER, RECYCLE, REUSE

Agricultural Research, Vol. 21, No. 7, p. 8, January, 1973. 6 fig.

Descriptors: *Feeds, *Recycling, Livestock, Poultry, Feedlots, Cellulose, Proteins, Methane, Costs.
Identifiers: *Refeeding, *Fiber, *Board.

Studies are underway on wastes from feedlots and poultry cages, with research emphasis on such diversified products as protein-rich feed for livestock, cellulose for fiber and pulp products and enzymes to digest fiber. Manure from corn-fed cattle was fractionated by screening and filtering. Chemists believe that if the undigested fiber can be separated from the protein, refeeding the fractions may be a way to reduce this source of pollution. The residue fraction served as a nutrient for a fungus that produces a fiber-digesting enzyme. In another study, fiber digestion with enzymes and heat points the way to complete recycling of chicken manure. Results showed that cellulose and hemicellulose did not build up in waste that was dried and refed as 25 percent of the chicks feed ration through 25 cycles. Fiber has been considered indigestible by poultry. In a study of microorganisms in feedlot wastes, Dr. Rhodes obtained an isolate of Salmonella. Although only one pathogen was present among 1,300 isolates, Dr. Rhodes cautions, "indiscriminate refeeding of unsterilized feedlot waste could be hazardous." (Cameron-East Central).

## 1947 - A4, B1 400

## LITTLE POLLUTION FROM THIS FEEDLOT

Agricultural Research, Vol. 18, No. 6, p. 10-11, December, 1970. 1 fig.

Descriptors: *Feedlots, *Nebraska, Analysis, Nitrates, Cores, Nitrification, Climates.
Identifiers: *Groundwater pollution, Manure pack.

The results of an investigation concerning nitrate pollution of a shallow groundwater table, conducted on a live cattle feedlot in Nebraska, are discussed. The 120-by-300 ft. lot was chosen for study because of such conditions as: stocking rate of 400 sq. ft. per animal; little manure removal; highly permeable soil; fluctuating high water table; and little surface drainage. Observations and measurements indicated that the manure pack (nearly 1 ft. thick) and the soil and manure form a common interface that effectively bars water movement. Analysis of soil core samples showed that downward movement of nitrates and other forms of nitrogen in the soil is minor. [illegible]

## 1948 - A9, E3, F1 300

## THE EFFECTS OF FEEDING A HIGH CONCENTRATE RATION CONTAINING 25% GROUND BEEF MANURE TO FATTENING HEIFERS IN CONCRETE AND SOIL SURFACED LOTS

Department of Agricultural Engineering,
Kansas State University, Manhattan.
C. L. Drake, L. I. Smart, E. F. Smith, and R. I. Lipper.
55th Annual Cattlemen's Day, Kansas Agricultural Experiment Station, Kansas State University, Manhattan, May 1, 1968, Bulletin 518, p. 57-60, 3 tab.

Descriptors: *Feeds, *Performance, *Feedlots, *Costs, Analyses, Salmonella.
Identifiers: *Fattening heifers, *Concrete surface, *Soil surface, *Manure.

The purposes of this project were to compare a ration containing 25 percent ground beef manure with a conventional ration and to study the influence of concrete or soil surfacing on animal performance. Heifers on concrete-surfaced lots gained slightly more and were more efficient. Concrete-surfaced lots are faster and easier to clean than unsurfaced lots. Feed efficiency was the same for control heifers in both concrete-and soil-surfaced lots. Differences in feed costs per hundred weight were small in all cases. Samples of manure were analyzed in the veterinary diagnostic laboratory and found free of Salmonella organisms. (Cartmell-East Central).

## 1949 - B3, E2 600

## ERODIBILITY FACTOR OF BEEF CATTLE MANURE

Soil Conservation Service,
United States Department of Agriculture,
Effingham, Illinois.
J. L. [illegible] and D. L. Day.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 19 p. 1 fig. 9 tab. 8 ref.

Descriptors: *Cattle, *Feedlots, *Solid wastes, *Waste disposal, Rainfall, Slopes.
Identifiers: *Erodibility factor, *Universal Soil Loss Equation.

The primary objective of this study was to develop a method of predicting manure solids loss from feedlots and areas where manure has been spread. Factors such as rainfall amount, intensity, slope, and erodibility of feedlot surfaces were included in the study. It was found that the Universal Soil Loss Equation dealt with many of the factors which are significant in manure solids movement. The erodibility factor obtained for manure solids loss was [illegible]. This prediction method can be very useful for evaluating or comparing locations for new feedlots and areas where manure is to be land-spread. It can also be used to evaluate the effects of slope, slope length, and various other factors on the solids loss expected from any given feedlot or field. (Cartmell-East Central).

## 1950 - B1, D1, E3 100

## EFFECT OF PROCESSING METHOD OF BROILER LITTER ON NITROGEN UTILIZATION BY LAMBS

Department of Agricultural Chemistry,
Missouri University, Columbia.
[illegible]
[illegible]

Descriptors: [illegible]
Identifiers: [illegible]

Experiments were conducted to study the effect of acidifying broiler litter with sulfuric acid prior to processing on nitrogen loss during dry heat treatment. Two metabolism trials were conducted to study the effects of different methods of processing broiler litter on digestibility and nitrogen utilization by lambs. The rations containing litter were readily accepted by wethers and no feed was refused during the two trials. The apparent digestibility of dry matter, crude protein, ether extract and NFE did not differ significantly among rations containing litter. No significant differences were observed for blood urea or the ruminal fluid parameters. Values for ruminal fluid, pH, and volatile fatty acid concentration indicate that rumen fermentation was not greatly altered by feeding litter processed by different methods. (Cartmell-East Central).

## 1951 - B1, C2, C3 100

## EFFECT OF MOISTURE CONTENT ON THERMAL DIFFUSIVITY OF BEEF MANURE

Design Engineer, Melroe Company,
Bismarck, North Dakota.
R. L. Houkom, A. F. Butchbaker, G. H. Brusewitz.
Transactions of the American Society of Agricultural Engineers, Vol. 17, No. 5, p. 973-977, September-October, 1974. 4 fig. 2 tab. 12 ref.

Descriptors: *Moisture content, *Effects, *Thermal conductivity, *Specific heat, *Bulk density, Design, Drying.
Identifiers: *Thermal diffusivity.

The objective of this project was to determine the thermal conductivity, the specific heat, and the bulk density of fresh cattle manure as affected by moisture content in order to estimate the thermal diffusivity. The results indicated that conductivity and bulk density varied with moisture content with a considerable increase occurring from 45 to 65 percent moisture content; the material was extremely sticky in this range of moisture contents. Thermal diffusivity was essentially independent of moisture content. (Cartmell-East Central).

## 1952 - B2, C5 600

## EFFECT OF SPRINKLING ON LIQUID ANIMAL WASTE PROPERTIES

Environmental Chemist,
Minnesota Mining and Manufacturing Company,
St. Paul.
S. R. Welch and P. R. Goodrich.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. [illegible], 16 p. 4 fig. 2 tab. 8 ref.

Descriptors: *Sprinkling, *Liquid wastes, *Chemical properties, *Physical properties, Livestock, Moisture content, Chemical oxygen demand, Ammonia.
Identifiers: *pH.

The main objective of this research was to determine whether or not any physical or chemical changes occurred in liquid animal waste materials as a result of pumping and sprinkling. Specific characteristics observed were moisture content, chemical oxygen demand, ammonia content and pH. The types of wastes observed were beef cattle, dairy cattle, and swine wastes. [illegible] (Cartmell-East Central).

## 1953 - D4 600

## A MECHANIZED COMPOST [illegible] FOR ANIMAL WASTE

Agricultural Engineering Department,
Maryland University, College Park.
J. W. Hummel, W. F. Schwiesow, and G. B. Willson.
Presented at Annual Meeting, American Society of Agricultural Engineers, 1972, Paper No. 72-456, 15 p. 6 fig, 6 tab, 6 ref.

Descriptors: *Design data.
Identifiers: *Mechanized compost channel, *Dairy manure, *Power requirements.

An elevating mechanism with supporting carriage was designed based on preliminary data and observations. The mechanism passed through the channel to mix, agitate and move the composting mass an increment of the channel length. Thus, the elevating mechanism served a dual role as an agitator and as a material transport device. Details of the carriage design are given. Design modifications are necessary for more efficient operation of the system, but the mechanized channel has proved to be a promising device for composting agricultural wastes. (Cartmell-East Central).

## 1954 - A1, B1 600

## EXPERIENCES WITH OXIDATION DITCHES IN A PULLET GROWING HOUSE

Research Engineer,
Huskee-Bilt Construction Company
Monmouth, Illinois.
J. S. Stevenson and L. J. Roth.
Presented at the 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-452, 8 p. 1 fig, 1 ref.

Descriptors: *Poultry, *Design, *Costs, *Performance.
Identifiers: *Oxidation ditch, *Pullet growing house, *Waste Management.

An account of some experiences with oxidation ditches in a commercial pullet rearing operation is presented. Two identical side-by-side oxidation ditches were operated continuously for eighteen months in a 32,000-bird pullet growing house. The design criteria of 0.3 cubic feet of liquid volume and 8,000 birds per standard eight-feet aerator proved adequate. One ditch caused no problems with foaming or odor. The other ditch, started at a shallower rotor immersion and subjected to various experiments regarding liquid velocity and rotor immersion, exhibited severe foaming for four months. The foaming ceased after withdrawal of most of the liquid followed by addition of liquid from the non-foaming ditch. Dilution water was regularly added to the ditches to make up for evaporation loss and to keep the solids content at a desired level. Because effluent from the ditch dries readily and without odor on a drying bed and because it can be handled easily with conventional manure handling equipment, this waste management system is worth considering. The cost of operation is high, but this cost is offset partially by substantial reductions in labor, and perhaps by improved bird health. (Cartmell-East Central).

## 1955 - B3, D1, E3 400

## FEEDING PELLETED DRIED POULTRY LITTER TO HOLSTEIN STEERS

Animal Nutrition Consultant,
Modesto, California.
A. A. Jimenez.
Feedstuffs, Vol. 46, No. 47, p. 20-21, November 18, 1974. 7 tab, 0 ref.

Descriptors: *Feeds, *Performance, *Cattle, *Costs.
Identifiers: *Dried poultry litter, *Refeeding.

The purpose of the experiment was to obtain data on weight gains, feed efficiency ratios and the cost of gains in growing steers fed substantial amounts of KOPRO. Another objective was to ascertain the validity of the energy value of KOPRO obtained from in vitro studies using the volatile fatty acid production litter which has been naturally dried, then ground and pelleted at high temperatures to eliminate pathogens. The two experimental groups of steers receiving KOPRO gained well, but with the exception of the first period, they never quite matched these gains of the control pens. The cost per unit of gain consistently favored the KOPRO-fed groups. During the entire trial no health problems associated with the feeding of KOPRO were observed. Cattle consumed KOPRO readily and with good appetite. (Cartmell-East Central).

## 1956 - A1, B2, E2 100

## DISPOSAL OF EFFLUENT FROM A BEEF CATTLE FEEDLOT RUNOFF CONTROL HOLDING POND

J. A. Nienaber, C. B. Gilbertson, T. M. McCalla, and F. M. Kestner.
Transactions of the ASAE, Vol. 17, No. 2, p. 375-378, March-April, 1974. 1 fig, 6 tab, 11 ref.

Descriptors: *Feedlots, *Cattle, *Application methods, *Sampling, *Nutrients.
Identifiers: *Runoff control, *Effluent disposal, *Holding pond.

Results are given for a field study initiated in 1970 to determine the minimum area required for feedlot runoff disposal as affected by applied nutrients and water and disposal area runoff control requirements. A minimum area of one-half acre disposal area per acre of feedlot did not impair crop production or cause a pollutant accumulation in the soil profile for the two year test period. Vegetation yields indicated no discrimination by the cattle grazing on effluent treated areas. A mixture of grasses resulted in the dominance of two species of grass — bromegrass and intermediate wheat grass. Intermittent effluent application by on and off cycling resulted in a higher total application without runoff based on application amounts attained in 1971 and 1972 under similar late fall climatic conditions. Final design for this experiment provides for return of surface runoff from the disposal area to a holding pond for recycling. (Cartmell-East Central).

## 1957 - A1 400

## AMMONIA AND RELATED GASES EMANATING FROM A LARGE DAIRY AREA

R. E. Luebs, A. E. Laag and K. R. Davis.
California Agriculture, Vol. 27, No. 2, p. 11-12, February, 1973. 2 fig, 2 tab.

Descriptors: *Ammonia, *Water pollution, *Dairy industry, Odor, Sampling, California.
Identifiers: *Volatilization, *Amines, Chino-Corona area.

Volatilization of nitrogen from animal wastes in combined forms, principally ammonia, can constitute a real problem. Amines that form can cause odor. Ammonia that forms may be absorbed from the atmosphere by surface waters. Combined with ammonia enriched rain water, such absorption could create a health hazard to persons or animals drinking the water. Approximately 400 dairies serving the greater Los Angeles area are located in 40 square miles near Chino, California. Sampling sites were located a minimum of 300 feet from the nearest dairy corral to permit representative sampling. Ammoniacal plus possibly small amounts of amine nitrogen were 20 to 40 times higher in the dairy area than in an urban area 7 miles upwind from the dairy area. The area over which the atmosphere was enriched totalled 150 square miles, 3.7 times greater than the area where the dairies were concentrated. Such concentrations would be a real danger to surface waters in the area. Fortunately, there are no important open storage water reservoirs in the Chino-Corona dairy area. (Cartmell-East Central).

## 1958 - A4, B2, E2 600

## LYSIMETER STUDIES WITH LONG TERM APPLICATION OF SWINE LAGOON EFFLUENT

Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh, North Carolina.
R. L. Parker, J. Wang, M. R. Overcash, and F. J. Humenik.
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4036, 13 p. 10 tab.

Descriptors: *Lagoons, *Effluents, *Application rates, *Lysimeters, *Nitrogen, *Phosphorus, Oxygen demand.
Identifiers: *Swine, *Groundwater pollution, *Removal, Organic carbon.

The application of swine waste lagoon effluent to lysimeters exposed to weather conditions up to a hydraulic rate of 1 inch per week and a process load of about 3000 lbs. nitrogen/acre/year continuously for over two years has resulted in essentially complete removal of phosphorus and excellent reduction of oxygen demand and organic carbon. Investigation of lysimeters with water table control showed that additional nitrogen reduction, specifically lower nitrate concentrations, can be achieved without supplemental carbon addition and with no decrease in the associated removal of organic carbon and oxygen demand. Removals of organics and nitrogen were reduced when the soil surface remained saturated either due to poor infiltration or control of the water table too near the soil surface. It was determined that controlled denitrification could provide for nitrogen reduction of soil water, and if the land disposal site were properly located and managed, a significant lowering of groundwater nitrate concentrations could be obtained before the flow left the owner's property. (Cartmell-East Central).

## 1959 - A1, B1, D1, E3 300

## ANIMAL WASTE CONVERSION SYSTEMS BASED ON THERMAL DISCHARGES

Department of Soil Science,
Oregon State University, Corvallis.
L. Boersma, E. W. R. Barlow, J. R. Miner and H. K. Phinney.
Special Report 416, Agricultural Experiment Station, Oregon State University, Corvallis, September, 1974, 34 p. 12 fig, 11 tab, 96 ref.

Descriptors: *Recycling, *Animal wastes, *Feeds, *Methane, *Electric power industry, Proteins, Anaerobic digestion, Costs, Pollution abatement, Nutrients.
Identifiers: *Refeeding.

Society faces many problems related to its growth in numbers and standard of living. Of major concern is environmental degradation resulting from pollution and the consumptive use of non-renewable natural resources. An animal waste management scheme was developed on the premise that one solution to these problems is the development of integrated production systems with recycled sources. The waste product of one industry must become the raw material for another. The feasibility of using waste heat from steam electric plants to sustain a food-producing complex which recycles nutrients is analyzed. Specifically, it is proposed to use microorganisms to convert animal waste into a high protein animal feed and a methane-rich fuel gas. Waste heat from steam electric plants is used as a low cost source of energy for maintaining stable, elevated temperatures in anaerobic digesters and single cell protein production units. Benefits to society include: improved efficiency of energy use and food production, minimization of pollution problems associated with food production, recycling of raw materials, and conservation of non-renewable resources. (Boersma, Barlow, Miner and Phinney).

## 1960 - B1 100

### COMPARISON OF SELECTED ENVIRONMENTAL CONDITIONS AND BEEF CATTLE PERFORMANCE IN POLE TYPE AND CLOSED ENVIRONMENTS

Agricultural Engineering Department,
South Dakota State University, Brookings.
M. A. Hellickson, W. B. Witmer and R. Barringer.
Transactions of the ASAE, p. 536-538, 542, 1972. 6 fig, 14 ref.

Descriptors: *Performance, *Environmental control, *Cattle, Temperature, Ventilation, Humidity.
Identifiers: Slotted floor.

Producers of feeder cattle have begun to adopt controlled environment units for confined production of feeder cattle. Little is known, however, of the effects of such units on beef production. An evaluation and comparison of the performance of beef cattle reared in an open-front, pole-type building and in a closed environment building is presented. During the winter period, the environment had no significant effect on average daily gain or feed conversion of finished beef cattle. However, during the summer period, significantly higher average daily gains and feed conversions were found for the beef cattle finished in the pole barn. (Kehl-East Central).

## 1961 - A1, E2 600

### SIMULATION OF MISCIBLE DISPLACEMENT IN SOILS

Department of Agricultural Engineering,
Texas A&M University, College Station.
A. G. Smajstrla, D. L. Reddell and E. A. Hiler.
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974. 21 p, 9 fig, 27 ref.

Descriptors: *Infiltration, *Mathematical models, Soils.
Identifiers: *Miscible displacement, *Simulation model, *Numerical dispersion.

In today's agriculture the characterization of ion movement through unsaturated porous media is extremely important. A simulation model was developed for the simulation of the miscible displacement of a conservative solute during one-dimensional vertical infiltration into a homogeneous, isotropic porous media. To solve the infiltration problem, an explicit finite difference technique was used. The method of characteristics to eliminate numerical dispersion was used to solve the transient convective diffusion equation. The accuracy of the simulation model results compared well with analytical solution, experimental data and other simulations. The study concluded that the shape of the solute distribution curve with depth is relatively insensitive to the magnitude of the dispersion coefficient for porous media to which the functional relationship used apply and for the range of pore water velocities commonly encountered during infiltration into sand and clay loam soils. The research also concluded that the dispersion coefficients are much larger and solute curves are very different for nonhomogeneous, anisotropic porous media than for homogeneous media. (Kehl-East Central).

## 1962 - A1, B1, D1, E2, F3 200

### PROCEEDINGS OF CONFERENCES ON FARM ANIMAL WASTES, NITRATES AND PHOSPHATES IN RURAL WISCONSIN ECOSYSTEMS

Wisconsin University, Division of Economic and Environmental Development.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, [illegible] p.

Descriptors: *Farm wastes, *Nitrates, *Phosphates, *Wisconsin, Research and development.
Identifiers: *Waste management.

This conference considered several closely-related aspects of waste and nutrient management on rural Wisconsin farm land. The objectives of the conference were to provide background facts, new research findings, and suggestions for alternative management programs in rural areas. The conference dealt with three aspects of the agricultural sector's impact on environmental quality, namely farm wastes, nitrates, and phosphates as they affect water, food, and health. Techniques and designs for handling manure were considered. Action programs were discussed. (Cameron-East Central).

## 1963 - A1, E2 200

### SOURCES AND FATE OF "AVAILABLE" NITROGEN IN RURAL ECOSYSTEMS

Associate Professor of Soil Science, Wisconsin University, Madison.
D. R. Keeney and L. M. Walsh.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 22-40, 4 fig, 8 tab.

Descriptors: *Nitrogen, *Nitrates, *Runoff, *Groundwater pollution, Rural areas, Ecosystems, Crops, Soils.
Identifiers: Manure.

The most critical problem associated with nitrogen compounds in groundwater aquifers is the possible adverse health effects on humans and animals. All sources of nitrogen — precipitation, crop residues, soil organic matter, legumes, manure, and nitrogen fertilizer — are ultimately converted to the leachable $NO_3$-N form by soil bacteria. Nitrogen can be lost from the soils by crop removal, leaching, denitrification, and runoff. Losses of soil material and total nitrogen are directly related to amounts of runoff. Practices recommended for reduction of runoff losses include use of crop residues, application of animal manure in conjunction with crops, use of minimum tillage on slopes, and fertilization to stimulate early growth of crop. The total amount of $NO_3$-N in the soil profile can be related directly to the rate of nitrogen application and frequency of the fertilized crop in the rotation. Methods for controlling the rate of pollution of underground water are given. Also given are methods of reducing nitrogen input into water. (Cameron-East Central).

## 1964 - A4, B1 200

### MOVEMENT OF GROUND WATER

District Chief, United States Geological Survey, Madison Office.
C. L. Holt and D. A. Stephenson.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. 49-58, 1 fig, 7 ref.

Descriptors: *Groundwater pollution, *Movement, Waste disposal, Animal wastes, Flow systems.
Identifiers: *Contamination.

Theoretical approaches to definition of ground water flow systems and to ground-water-surface-water relationships have been formulated over the past [illegible] years. Scientists have demonstrated that flow systems can be defined in the field with empirical geological and hydrological techniques. These techniques enable proper siting to waste disposal systems and enable a [illegible] to know to which direction and at what rate effluents will travel if they are in the ground, and where they will surface. Ground-water is derived from precipitation by infiltration through soil and includes all water within the saturated zone below the water table. The pattern of ground-water flow from a recharge to a discharge area constitutes a dynamic flow system. Problems involving ground-water contamination are difficult to solve because the investigator cannot trace the ground-water contaminant by a simple inspection at the land surface. The first indication that a ground-water problem even exists comes when a water supply well begins to produce water containing an offensive substance. The resolution of the problem of ground-water contamination is discussed. (Cameron-East Central).

## 1965 - A1, B1, E1 200

### THE ROLE OF THE WISCONSIN DEPARTMENT OF AGRICULTURE IN AGRICULTURAL POLLUTION PREVENTION AND CONTROL

Secretary, Wisconsin Department of Agriculture.
D. E. Wilkinson.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. 119-124.

Descriptors: *Wisconsin, *Environment, *Animal wastes, Regulation.
Identifiers: *Agricultural pollution, *Pollution control.

Donald Wilkinson, Secretary, Wisconsin Department of Agriculture, is optimistic about the prospects of developing a quality environment, one in which there is a high degree of compatibility between the ecological and economic community. There is an ever-increasing problem of cohabitation. The important part of this human-animal relationship is waste disposal and a clean environment. Since the total farm income in Wisconsin exceeds 1.6 billion dollars and since the livestock industry produces about 86 percent of this total, animal waste disposal is very important. The Department of Agriculture is concerned with many other types of wastes as well. Wilkinson stresses that it is foolish to think that environmental pollution can be managed by assigning agricultural waste and pollution to farmers, industrial pollution to industrialists and other types of wastes to the public in general. He feels that environmental problems will be solved only by integrated effort and coordinated management of resources at the rural-urban interface. (Cameron-East Central).

## 1966 - A1, B1, E2 200

### SOIL POLLUTANTS AND THEIR EFFECTS ON CLEAN WATER

Department of Soil Science,
Minnesota University, St. Paul.
W. P. Martin.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. [illegible]

Descriptors: *Pollutants, *Water pollution, Animal wastes, Soil erosion, Pesticides, Fertilizers, Nutrients.

Municipal, industrial and agricultural wastes are major causes of pollution and all three must eventually be moderated if the purity of our lakes and rivers is to be restored or maintained. Especially troublesome are agricultural sources: animal wastes, eroded soil, fertilizers, and pesticides. The disposal of organic wastes from farm animals and from other sources related to the farm enterprise has become a major management problem. If land disposal of wastes is to be used, soil type, topography, and land availability should be carefully considered when locating feedlots and processing operations. Terracing, minimum tillage, and sod strips are means of combating soil erosion. Phosphatic fertilizers should be incorporated into the soil, if possible, in order to prevent it from being carried by runoff to surface waters. Measures should be taken to prevent nitrogen in fertilizers and organic wastes from entering surface and groundwater supplies. Pesticides must be continuously evaluated. It is likely that those presently hazardous compounds have [illegible] (Cameron-East Central).

### 1967 - A1, B1 200

### PHOSPHORUS IN OUR ENVIRONMENT

Wisconsin Department of Natural Resources.
J. M. Cain and J. E. Kerrigan.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. 134-137. 5 ref.

Descriptors: *Phosphorus, *Fertilizers, Surface waters, Environment, Wisconsin, Nutrients, Water pollution.
Identifiers: *Manure.

Historical background, characteristics, and principal producers of phosphorus are discussed at the beginning of this report. A major concern is the increased concentration of phosphorus in surface waters. Manure and commercial fertilizers are the major sources of plant nutrients in Wisconsin. Estimates show that 46 percent of the total phosphorus supplied to Wisconsin crops was from manure. Much of the manure was applied on frozen ground so that it contributed significant quantities of soluble phosphorus to the spring runoff. Complications to the problem of phosphorus imbalance in the environment include such factors as the broad expanses of land and water involved, the low phosphorus concentrations at which problems occur in lake waters and the abundance and low cost of phosphorus which often preclude profitable recovery of phosphorus. The phosphorus problem must be considered as part of a group of interrelated problems of soil erosion, nitrogen fertilization, waste treatment, water use, and land use. (Cameron-East Central).

### 1968 - A1, B1, E2 200

### PHOSPHORUS IN THE RURAL ECOSYSTEM — RUNOFF FROM AGRICULTURAL LAND

Assistant Professor of Soils,
Wisconsin University.
R. Powell and J. Densmore.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. 159-168. 8 tab. 1 ref.

Descriptors: *Phosphorus, Agricultural runoff, Water pollution, Soil erosion, Fertilizers, Animal wastes, Ecosystems.
Identifiers: Agricultural land.

Public concern over pollution of the environment has increased considerably. Concern about water quality is foremost because the main result is visible degradation of the water, notably the growth of algae and weeds plus possible contamination of drinking water supplies. Estimates show that less than one-third of the phosphorus entering Wisconsin waters comes from agricultural land. Agricultural sources of phosphorus are mainly soil erosion, fertilizers and manures. Applications of these products on snow covered, sloping fields can be potential sources of phosphorus pollution. Incorporation of animal manures immediately after application conserves the nutrients and also reduces the soil erosion potential of a sloping field. Judicious placement of manures, feeding operations and [illegible] handling of fertilizers and animal wastes will help to lessen public concern between agriculture and her urban neighbors. (Cameron-East Central).

### 1969 - A1, B1 200

### WHAT OUR MILK MARKETS REQUIRE

Chief, Section of Dairy & Milk Certification, Division of Health, Wisconsin Department of Health and Social Services.
[illegible]
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, February 1-5, 1971, p. 205-207. 3 ref.

Descriptors: *Milk, *Waste disposal, *Regulation, Dairy industry.
Identifiers: *Cleanliness, Flies, Milk Ordinance and Code.

Public health regulations for the protection of milk supplies have always called for the cleanliness of the cow, the barnyard, the milker and for the elimination of areas where flies may breed. Improper manure disposal induces the breeding of flies, which are considered capable of transmitting infection, by physical contact or through excreta, to milk and milk utilities. Cows should not have access to piles of manure in order to avoid the soiling of udders and the spread of diseases among cattle. The Milk Ordinance and Code lists six requirements which must be met before the disposal of animal wastes is deemed to be adequate. The emphasis is on keeping the dirt out of the milk supply, maintaining the cleanliness of cows, keeping the surroundings clean so that the cows will not become soiled, and preventing fly breeding. Other considerations are given for working out methods of adequate manure disposal. (Cameron-East Central).

### 1970 - A1, B1 200

### FARM ANIMAL WASTE MANAGEMENT: WHAT OUR MILK MARKET REQUIRES

Administrator, Food Division, Wisconsin Department of Agriculture.
N. E. Kirschbaum.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 208-210.

Descriptors: *Milk, *Animal wastes, *Waste disposal, *Dairy industry, Management, Wisconsin.

A rough estimate of the manure produced daily by dairy herds in Wisconsin is 200,000 tons. In the past, major efforts have been made to encourage daily removal and field spreading of animal wastes or manure. In General Order #134, certain provisions for the handling of dairy farm animal waste and human waste, as they would affect the production of milk, were established. Specific requirements found in the statutes are set forth in this report. These provisions are concerned primarily with the cleanliness of the cows, the breeding of flies, and the pollution of water used for drinking or for cleaning equipment. The daily removal and spreading of manure, which was previously recommended, is now being discouraged. Dairy farmers are now confronted with questions of lagoons, liquid manure handling operations, stacking of manure, and similar issues. All of these methods are unique in themselves and present problems with handling, odors, fly control, and possible water pollution. More research is needed to make certain that practical solutions are found for problems accompanying methods of animal waste storage and disposal. (Cameron-East Central).

### 1971 - A1, B2 200

### CONTROLLING BARNYARD RUNOFF

Soil Conservation Service, U.S. Department of Agriculture, Madison, Wisconsin.
[illegible]
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. [illegible].

Descriptors: *Waste disposal, Wisconsin, Feedlots.
Identifiers: *Runoff control, Barnyards, Soil Conservation Service.

A concerted effort has been made by the Soil Conservation Service, at the request of farmers, to provide technical assistance in planning and constructing needed measures to control feedlot and barnyard runoff. In providing a barnyard runoff control system, attention should be given to three basic steps: (1) making use of structures and practices that will intercept and divert all surface runoff not originating on the yard, (2) reshaping the lot to provide good surface drainage, and (3) collecting, conveying, storing and finally safely disposing of runoff from the livestock yard itself. To meet the problem in any feedlot or barnyard, one or perhaps all three of these steps may be needed. Temporary storage of barnyard runoff can be provided in a settling pond or basin and in a retention pond. Not only are good planning and construction essential for the success of farm animal waste disposal systems, but increasing attention will have to be given to maintenance and management. (Cameron-East Central).

### 1972 - A1, B1, E2 200

### PLANNING LAND APPLICATION OF MANURE

Extension Agricultural Engineer, Wisconsin University, Madison.
L. R. Massie.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 215-222. 6 tab, 2 ref.

Descriptors: *Planning, Agricultural runoff, Surface waters, Soils.
Identifiers: Land disposal, Manure.

The development of a system for land application of manure must consider land forms, surface runoff, and present or possible land use if organic pollution is to be kept to a minimum. Livestock producers now need to consider some additional dimensions when planning application of manure to their land. They must be concerned with movement of nutrients from their fields via the primary carrier, i.e., surface runoff water. Some soil conditions which may cause problems are internal drainage, slow water intake (infiltration) rates, rooting restrictions or shallow soils, erosion, and the location of the soil body on the landscape. A list of suggested practices for the application of manure to the land is given. Application of these practices will further the conservation effort for erosion control. Changes will be needed as additional information from research and experience become available. (Cameron-East Central).

### 1973 - A8, B3 200

### FLIES IN RELATION TO MANURE HANDLING

Extension entomologist, Wisconsin University, Madison.
W. L. Gojmerac.
Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. [illegible]. 1 tab.

Descriptors: *Waste storage, *Dairy industry.
Identifiers: *Flies, *Manure handling, [illegible].

A study was done to evaluate the fly problem on farms where manure was stored and to compare them to other nearby farms regularly removing manure. [illegible] (Cameron-East Central).

1974 - B1 200

### A PROCEDURE FOR DESIGN OF A MANURE STACKING FACILITY

**Extension Agricultural Engineer, Wisconsin University, Madison.**
**E. G. Bruns.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 227-232.**

**Descriptors: *Design, *Dairy industry, Agricultural runoff, Waste storage.**
**Identifiers: *Manure stacking.**

**Procedures for the design of a manure stacking facility are given for two different farms. There are five sections of design data for each farm. They are as follows: (1) livestock units, (2) daily manure production per animal unit per day, (3) solid storage requirements for 180 days of storage capacity, (4) runoff area, and (5) liquid storage capacity required for detention pond(s). (Cameron-East Central).**

1975 - B2 200

### LIQUID MANURE HANDLING

**Extension Agricultural Engineer, Wisconsin University, Madison.**
**T. J. Brevik.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. [illegible] 1 tab.**

**Descriptors: *Liquid wastes, *Waste storage, Lagoons.**
**Identifiers: *Waste handling, *Holding tanks.**

**Since manure is quite liquid naturally, there is considerable interest and research in handling it in liquid form. A good deal of the research underway today is directed toward some type of treatment while in storage — treatment which attempts to reduce the volume or to control odors. Terms, defined in this report, which relate to liquid manure storage and handling are: holding pond, anaerobic lagoon, aerobic lagoon, oxidation ditch, detention pond, biochemical oxygen demand (COD), and settling terrace. Most on-the-farm liquid manure storages are, at the present time, underground holding tanks. Considerations and problems associated with holding tanks are discussed in the remainder of this report. Publications dealing with liquid manure handling are listed and are available through the County Agricultural Extension Office or through the Agricultural Engineering Department. (Cameron-East Central).**

1976 - A5, B2, D1 200

### RESEARCH PROGRESS IN MANURE HANDLING AND TREATMENT SYSTEMS FOR LIVESTOCK

**Assistant Professor, Department of Agricultural Engineering, Wisconsin University, Madison.**
**J. C. Converse.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. [illegible] 6 fig, 3 tab, 10 ref.**

**Descriptors: Waste treatment, *Aerated lagoons, *Livestock, Research and development.**
**Identifiers: Odor control, Oxidation ditch, [illegible] systems.**

**Several treatment and handling systems for livestock wastes are discussed. [illegible] (Cameron-East Central).**

1977 - B1, E2 200

### UNIVERSITY OF WISCONSIN RESEARCH ON MANURE HANDLING

**Agricultural Engineering Department, Wisconsin University, Madison.**
**C. O. Cramer, R. F. Johannes, and G. H. Tempas.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 265-269, 4 ref.**

**Descriptors: *Wisconsin, *Research and development, Design, Management, Waste storage.**
**Identifiers: Waste handling.**

**Research at the University of Wisconsin Experiment Station involves a study of manure handling systems utilizing waste storage facilities. Researchers wish to determine proper management design in order to minimize pollution and preserve the plant nutrient value of the manure. The systems must meet sanitary regulations for the production of milk or demonstrate the feasibility of the systems which would justify changes in these regulations. This research is being carried on at three of the University Experiment Farms, The Electric Research Farm, River Falls State University Farm, and several private farm cooperators. The design and operations of each facility are discussed in this report. (Cameron-East Central).**

1978 - A1, B2 200

### LARGE COMMERCIAL FEEDLOTS — HOW WASTES ARE HANDLED IN THE WEST

**ARS-USDA, AERD, Nebraska University, Lincoln.**
**C. B. Gilbertson.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates in Rural Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. 270-279, 2 fig.**

**Descriptors: *Feedlots, *Nebraska, *Design, Performance.**
**Identifiers: *Waste handling, *Runoff control.**

**Research is underway for determining design factors for construction, installation and management of runoff control facilities on outdoor feedlots. There are three requirements for a [illegible] runoff control facility: (1) a debris basin, (2) a holding pond, and (3) disposal area. Two separate management designs are available for installation. They are the "batch" system and the "continuous flow" system. Both systems must be designed for removal of settleable solids from the runoff. Many factors must be [illegible] in the design of a feasible feedlot operation which will yield good animal performance and, at the same time, control all wastes, including surface runoff, groundwater contamination and nuisances such as odors, dust, and flies. Several steps are listed for designing and constructing a runoff control facility for a [illegible]. Assistance for design, layout and [illegible] may be obtained from local health authorities, Soil Conservation Service, Extension Agricultural Engineers, and practicing consulting engineers (Cameron-East Central).**

1979 A1, B2 200

### ACTION PROGRAMS FOR MANURE HANDLING

**Department of Poultry Science, Wisconsin University, Madison.**
**[illegible], and J. W. Crowley.**
**Proceedings of Conferences on Farm Animal Wastes, Nitrates and Phosphates, in Rural Wisconsin Ecosystems, Madison, Green Bay, and Eau Claire, Wisconsin, Feb. 1-5, 1971, p. [illegible]**

**Descriptors: *Legislation, Dairy industry, [illegible]**
**Identifiers: *Action programs, *Waste handling.**

**Requirements which need to be considered for the proper handling of manure are (1) regulations, enforcement agencies, and laws, (2) quantities of manure to be handled, (3) alternative approaches that are possible for the area and the species, (4) overall costs of different methods and approaches, and (5) economic limits within which the farmer can survive. Manure regulations for dairy farmers are particularly enforced and are specifically directed toward the assurance of milk quality. Clean cows and clean milking make daily cleaning essential. In addition, fly breeding and odors also must be controlled. A brief outline is given on groups which are concerned about waste disposal on the farm. Steps are suggested for an action program composed of all groups concerned. The goal of each program is to recycle the nutrients in manure. This must be done in the most economical manner that will produce a minimum of environmental pollution and that will not excessively offend any segment of the community. (Cameron-East Central).**

1980 - A9, B1 200

### THE REUSE OF OLD LITTER

**Wilson & Co., Inc., Poultry Division, Federalsburg, Maryland.**
**D. E. Davis.**
**Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 1-7.**

**Descriptors: *Litter, *Poultry.**
**Identifiers: *Reuse, *Built-up litter, *Marek's Disease, Composting.**

**About two years ago at the New Hampshire Poultry Disease Conference, Donald E. Davis reported that reusing litter in broiler houses aided in the reduction of Marek's Disease (MD). In an examination of clean-out vs. not cleaned out, the difference in condemnation based on USDA figures was .75 percent less on the flocks which were not cleaned out. The effect of the number of times broilers were placed on built-up litter was studied. There was a slight increase on the first and second time built-up. Of the different types of litter studied, softwood material gave better results and was more readily available and suitable to poultry production needs. Floors play an important role in MD control. Dirt floors gave better MD control than did other types. Although built-up litter will not bring MD to a .0 percent incidence, it would seem that we are forced to stay with the built-up litter program. (Cameron-East Central).**

1981 - B2, C5, D2 200

### DEHYDRATION AN ECONOMICAL SOLUTION TO POULTRY MANURE PROBLEMS

**Poultry Science Department, Pennsylvania State University, University Park.**
**G. O. Bressler.**
**Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 24-40, 5 tab.**

**Descriptors: *Dehydration, *Economics, *Poultry, *Farm wastes, *Waste treatment, Waste disposal, Odor.**
**Identifiers: Fly control.**

**Because of the huge problems of waste disposal in the poultry industry, many methods are currently under investigation to deal with these wastes. Perhaps the most promising means of disposal begins with dehydration. Penn State has been investigating dehydration with the objectives of removing as much water as possible, eliminating odors and flies, and developing an automatic system of manure handling. Experiments were conducted from 1967-1969 with very [illegible] results. The weight of the [illegible] reduced to about one-fourth of [illegible] weight when the water was [illegible] inside the house were [illegible]. High velocity air [illegible] and prevented excessive bacterial growth. [illegible] reduced, and since manure was [illegible] and removed while the birds were [illegible] there wasn't a large accumulation**

of manure. This in turn reduced "downtime" between flocks. Fly breeding areas were constantly destroyed so there were few fly problems. Finally, the overall capital investment requirements were low when compared to other methods. (Russell-East Central).

1982 - A1, B1, E2, E3 200

### WHAT HAPPENS IN THE SOIL WHEN MANURE IS USED?

G. H. Enfield.
Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 50-56.

Descriptors: *Soils, *Bacteria, *Chemical reactions, *Decomposition, *Nitrogen, Odor.
Identifiers: *Land disposal.

When manure is applied to the soil, bacterial activities and biological and chemical reactions take place. These reactions are dependent on the following factors: (1) rate of application, (2) nature of the soil to which it is applied, (3) moisture content, (4) temperature, (5) availability of oxygen, (6) nature of the litter, (7) relation of nitrogen to carbon, (8) degree of acidity and (9) whether the manure left on the surface is incorporated or plowed under. In order to make these biological and chemical reactions work for us, certain steps need to take place. (1) Manure should be applied to soils deficient in nitrogen, phosphorus and potassium. (2) The crop grown should be responsive to these elements. (3) Manure should be spread thinly and disced under to prevent odor. (4) A well-limed sandy surface layer will help prevent the escape of ammonia to the atmosphere. (5) An impervious layer of clay under the sand will prevent excess nitrogen from leaching through the soil. (6) The area could be seeded with a fast development grass crop to convert $NO_3$ to less objectionable organic matter. After several years this topsoil could be sold as a potting mixture, as rich topsoil for golf courses, etc. (7) Another boon from this type of land disposal is an increase in the earthworm population. (Cameron-East Central).

1983 - B3, E2, F1 200

### USE OF POULTRY MANURE AND LITTER IN CROP PRODUCTION

Plant Science Department,
Delaware University.
L. J. Cotnoir.
Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. 131-139.

Descriptors: *Crop production, *Fertilizers, Litter, Moisture content, Nutrients, Costs.
Identifiers: Excreta, Application rates.

The use of poultry manure as a fertilizer for crops has decreased drastically in recent years for a number of reasons. Five factors influence the use of poultry manure on crops: (1) moisture content, (2) variability of the product, (3) nutrient balance of manure, (4) residual effect due to manures, and (5) costs of handling. The value of one ton of dry poultry manure is $11.86. If it contains 50 percent moisture, the value is only half of $5.93. Guidelines can be established for the most effective and efficient use of poultry manure in the following areas: (1) manure distribution, (2) land area, (3) quantity of manure, (4) crop benefits, and (5) when to apply. Recommendations on when to apply to the soil for specific crops is discussed. (Cameron-East Central).

1984 - B1 200

### REVIEW OF AVAILABLE LITTER MATERIALS AND THEIR ADVANTAGES AND DISADVANTAGES

Department of Poultry Science,
Texas A&M University, College Station.
J. R. Howes.
Proceedings of the 1969 National Poultry Litter and Waste Management Seminar, Salisbury, Maryland, September 29-30, 1969, p. [illegible] 1 ref.

Descriptors: *Poultry, *Litter, *Material, Economics.

Requirements for good litter material are that they be: inexpensive, available, absorbent, dust free, easy to transport, buoyant, not consumed by birds, disease free and reusable if possible. Problems connected with litter are economical disposal and management. The greatest use of litter in North America today is for broilers, turkeys, layer replacements, and game birds. Litter materials that are available in North America are listed. Advantages and disadvantages of each litter material are given. (Cameron-East Central).

1985 - A1, E2 400

### IRRIGATION RESIDUES

J. P. Law and J. L. Witherow.
Journal of Soil and Water Conservation, Vol. 26, No. 2, p. 54-56, March-April, 1971. 13 ref.

Descriptors: *Irrigation effects, *Pollutants, Water quality control, Waste water (pollution), Pollution abatement, *Farm wastes, Return flow, I.
Identifiers: Salinity control.

The water quality problems associated with irrigation return flow are difficult to control. The major problems are the increased dissolved salt and nutrient content of waters draining from irrigated land. The difficulty in control is due to the diffuse nature of irrigation return flows coming from large irrigated areas and from both surface and subsurface drainage. Insufficient research has been devoted directly to the solution of return flow quality problems. Studies are needed to answer specific questions regarding both quantity and quality of irrigation residues. Possible control measures are discussed, but specific data concerning their effectiveness in abating water quality degradation are lacking. These must be evaluated and suitable management practices implemented to control water quality problems rising from irrigation. (EPA Abstract).

1986 - A4, B1, E2, E3 200

### DISPOSAL AND RECYCLING OF AGRICULTURAL AND MUNICIPAL WASTES

Agricultural Engineering Department,
Colorado State University, Fort Collins.
T. Trout, J. L. Smith, and W. Downs.
Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 217, p. 86, 1974.

Descriptors: *Waste disposal, *Recycling, *Municipal wastes, *Colorado, Solid wastes, Slurries, Lagoons, Groundwater, Feedlots.
Identifiers: *Agricultural wastes, Waste collection.

The Agricultural Engineering Department of Colorado State University is currently involved in three research projects dealing with the disposal and recycling of solid and slurrified wastes. A subsurface sludge injection machine is used by the city of Boulder to dispose of part of their digested and slurrified sludge. The material is pumped from holding tanks through underground main lines to risers in the field and then to the operating machine via 660 feet of 4 inch diameter flexible rubber hose. A similar project at Fort Collins involves subsurface disposal of slurrified feedlot wastes. The project will be conducted in the same manner as the Boulder operation. The third project is concerned with the "harvesting" of cattle manure as an integral part of a waste recycling research program being investigated. To facilitate speedy handling of the material, a machine capable of rapidly collecting large quantities of manure from concrete floors is being developed. (Cameron-East Central).

1987 - A1, A4, B1 200

### BEEF CATTLE FEEDLOTS: IMPACT ON UNDERLYING SOIL

Agricultural Research Service, U. S. Department of Agriculture, Ft. Collins, Colorado.
[illegible]
Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 218, p. 86, 1974.

Descriptors: *Soil profiles, *Groundwater, *Feedlots, Air pollution, Water pollution.
Identifiers: Manure pack.

Studies on commercial and experimental installations were made to determine changes in soil profiles and ground water beneath earth-surfaced beef cattle feedlots. The kinds and amounts of soil gases as well as the chemical constituents of the soil solutions are influenced by the depth and water content of a manure pack and seasonal soil temperatures. An experimental feedlot has been built to evaluate schemes to minimize both air and water pollution. A feedlot, with intact manure pack and under continuous use at a sufficient stocking rate, does not appear to be a pollution hazard to soil and underground water. (Cameron-East Central).

1988 - D1 200

### MODIFICATION AND ENZYMATIC HYDROLYSIS OF CATTLE FEEDLOT MANURE

Microbiology Department, Colorado State University, Ft. Collins.
G. K. Elmund, D. W. Grant and S. M. Morrison.
Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 221, p. 87, 1974.

Descriptors: *Feedlots, *Cattle, Cellulose, Cotton.
Identifiers: *Manure, *Fenton's reagent, Ferrous sulfate, Hydrogen peroxide, Enzymatic hydrolysis.

Evaluations were made of the use of Fenton's reagent (ferrous sulfate and hydrogen peroxide) for modifying the cellulosic fraction of cattle feedlot wastes. Manure samples were reacted in solution with 0.22 mM ferrous sulfate and initial hydrogen peroxide concentrations ranging from 0.1 to 5 percent. Manure and cotton substrates were also reacted with Fenton's reagent for two days and residual hydrogen peroxide removed with catalase. Results indicate that treatment of manure and cotton with Fenton's reagent modifies the cellulosic materials in such a manner that subsequent enzymatic hydrolysis is facilitated. The reaction products of such treatments are more readily biodegradable and may serve as substrates with biologically enhanced nutritional value in proposed refeeding processes. (Cameron-East Central).

1989 - E3, F1 200

### RECYCLING ANIMAL WASTE AND BY-PRODUCTS

Department of Animal Sciences,
Colorado State University, Fort Collins.
J. K. Matsushima.
Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 220, p. 87, 1974.

Descriptors: *Recycling, *Cattle, *Feeds, *Economics, *Performance.
Identifiers: *Animal wastes, *Paunch content, *Bloodmeal, *Protein content, *Refeeding.

Paunch content (10 percent protein content on dry basis) is a useless waste product of beef packing plants. Bloodmeal (about 80 percent protein) is also a byproduct of packing plants, but it can be merchandised. When the two ingredients are dried and blended in equal proportions the protein content is similar to cottonseed meal (41 percent protein) or other similar supplements commonly used in feedlot rations. A feeding trial was conducted to evaluate three different protein supplements. The three treatments were: (1) control supplement, basically cottonseed meal; (2) mixture of dried paunch-bloodmeal supplement; and (3) combination of cottonseed meal with paunch-bloodmeal. In spite of a temporary refusal of feed during rainy periods, the cattle fed the paunch-bloodmeal supplement consumed 40 pounds more corn per head over the [illegible] day period as compared to the controls. With the greater feed consumption, the cattle weighed 22 pounds heavier per head when marketed. This increase was 4 percent greater with a feed saving of 3 percent per pound of beef produced. (Cameron-East Central).

1990 - D1, E3 200

## THE DEVELOPMENT OF MANURE HARVESTING PRACTICES FOR BEEF FEEDLOTS

**Agricultural Engineering Department, Colorado State University, Fort Collins**
**R. Hansen and S. Marne**
**Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 227, p. 89, 1974.**

**Descriptors: *Feedlots, *Harvesting, *Management, Cattle, Recycling**
**Identifiers: *Manure**

The recycling of beef feces is being done for various purposes. Preliminary investigations have indicated the physical and nutritional characteristics of the manure are extensively affected by the environment and management practice to which the manure is subjected before harvesting. A study is being initiated to determine the effects of controlled environment and constant management factors on the feed value and physical characteristics of manure. The field study will be conducted to determine the effects of measured operating conditions as related to changes which occur in manure with time and environment. Laboratory investigations will consist of a simulation study with controlled environment to determine the effect of various factors on manure. When the effects of this study are known, management programs can be developed to maximize the utilizable components of the manure and minimize the handling and processing requirements. (Cameron-East Central).

1991 - A1, E2 200

## EFFECT OF THE APPLICATION OF BEEF-CATTLE-FEEDLOT MANURE ON CORN PRODUCTION

**Agronomy Department, Colorado State University, Fort Collins**
**T. A. Ruehr and R. R. Sabey**
**Proceedings of the 87th Annual Research Conference, Colorado State University, Fort Collins, Colorado, Number 223, p. 88, 1974**

**Descriptors: Cattle, *Feedlots, *Silage**
**Identifiers: *Manure, *Corn production, Application rates**

Beef-cattle-feedlot manure was repeatedly applied to a Nunn clay loam on the Agronomy Farm at Fort Collins for three years starting in 1971. Another study was initiated in 1972 on adjacent plots to evaluate the residual effects of a single application of manure with rates up to 480 tons per acre. Corn silage was grown on the plots each year and corn grain yields were determined in 1973. The results of each year are given. These results suggest that manure applications of up to 480 tons per acre can produce high silage yields but the quality of the forage should be considered. (Cameron-East Central).

1992 - A2, B1 600

## EFFECT OF CLIMATE ON THE SELECTION OF A BEEF HOUSING SYSTEM

**Department of Agricultural Engineering, Oklahoma State University, Stillwater**
**[illegible] and J. E. Garton**
**Presented at the [illegible] Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. [illegible], [illegible] p. [illegible] fig. [illegible] tab. [illegible] ref.**

**Descriptors: *Climatology, *Feedlots, *Cattle, Air temperature, Evaporation, Precipitation, [illegible], Costs, Performance, Great Plains**
**Identifiers: *Housing, Waste management, [illegible]**

This study, a portion of a major investigation devoted to evaluation of beef waste management alternatives, examined the relationship between climate, the beef feeding industry and its related waste management system. The objectives of the major investigation were: (1) to develop beef feedlot design criteria that minimize pollution by runoff waste and facilitate handling of solid and liquid animal waste, and (2) to examine alternative feedlot waste disposal systems to determine minimum cost systems for effective waste disposal. Factors that should be considered in feedlot site selection are marketing and transportation, feeder cattle supply, feed grain supply, land prices, agricultural practices and local topography, soil condition and climate. Environmental factors affecting animal performance are physical, social and thermal. The feedlots surveyed were of two types: open feedlots and those with confinement buildings. The three variables used to develop the climatic zones for livestock production were air temperature, evaporation and precipitation. The climatic zones were then subdivided into optimum and secondary areas. A discussion and comparison of open feedlot and confinement building operations' design and costs were given. The Southern Great Plains region of the United States was considered as an optimum climatic area for beef production year-around in open feedlots. (Kehl-East Central).

1993 - B1, D2 600

## STATIONARY SLOPING SCREEN TO SEPARATE SOLIDS FROM DAIRY CATTLE MANURE SLURRIES

**Department of Agricultural Engineering, Wisconsin University, Madison**
**R. E. Graves and J. T. Clayton**
**Presented at the 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-15, 1972, Paper No. 72-915, 16 p. 4 fig. 6 tab. 8 ref.**

**Descriptors: *Dairy industry, *Slurries, *Separation techniques, *Screens, Sludge, Flow ratio, Organic matter, Nitrogen**
**Identifiers: Total solids, Volatile solids, Settleable solids**

When a water manure slurry is allowed to stand, a heavy mat and sludge usually form. Removal of these formations is often difficult. Slurries such as that of dairy cattle manure create special problems because of the quantities of fibrous material they contain. This study evaluated the usefulness of stationary sloping screens (.010, .020, .030, and .040 inch bar spacing) for the removal of solid particles from dairy cattle manure slurries. A commercially available stationary sloping screen was found effective. Tests compared the solids removal for slurries of dairy cattle manure ranging from 20:1 to 2:1 (water to wet manure by weight). The comparison tests indicated the following: (1) For slurries ranging from 20:1 to 3:1, the screens worked well. But slurries of 2.5:1 and 2:1 caused blinding of the screen and produced an effluent with fluffy floc that did not settle well. (2) With bar spacing from 0.030 to 0.010 inch, the amount of settleable solids remaining in the screen effluent decreased. (3) A decrease in flow rate must accompany a decrease in bar spacings. (4) As bar spacings decreased, the moisture content of screened solids increased. (5) In general, although solids removed by the screen were wet, they could be handled and piled much like wet manure. (6) When allowed to stand, the excess water that was removed with the solids drained out. (7) Solids that were removed by the screen were high in crude fiber and had a low ratio of organic matter to [illegible]. Agricultural applications were given. (Kehl-East Central).

1994 - A3, B2, F1 400

## THIS PARLOR MAKES USE OF NEW IDEAS

**[illegible]**
**Hoard's Dairyman, Vol. [illegible], No. [illegible], p. [illegible], October [illegible], 1974, [illegible] fig.**

**Descriptors: *Dairy industry, *Design, *Montana, Ventilation, Odor**
**Identifiers: Holding pen, Waste pit, Flushing, Milking pit, Slatted floor**

Ralph Parker and his sons at Sun River, Montana, were faced with the problem of replacing an old, 4-stall, u-shaped parlor with side-opening stalls. The old setup caused the milking time and the cleanup time to be too long. The rancher chose the herringbone design. A 60-cow holding area and a 10-cow double-5 herringbone parlor were constructed. In creating a ventilation system, the following factors were considered: comfort of the milkers, prevention of freezing when unoccupied, removal of heat produced by the animals in warm weather, and odor control. These objectives were met by continuous ventilation from the manure storage pit beneath the slatted holding area and the addition of heat intermittently. For cleaning purposes, the floor of the milking pit and the floor of the milk house were constructed on the same level. Wash water and flushing from both areas were to drain by gravity into the manure pit beneath the holding area. To accomplish this, the holding area floor was sloped upward 28 inches. This provided a 20-foot-long ramp for entering and leaving the stalls. Slate for the floor could not be obtained in Montana, so Parker made his own. Costs are listed. It was advised that if a system of the type described is planned, approval should be obtained from the health authorities having control of the sale of the milk before construction is begun. (Kehl-East Central).

1995 - A1, B1 600

## A TWO-CROP FISH PRODUCTION SYSTEM

**Department of Entomology and Fisheries, Coastal Plain Experiment Station, Tifton, Georgia**
**T. K. Hill, J. L. Chesness, and E. E. Brown**
**Presented at the 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-526, 13 p. 8 fig.**

**Descriptors: *Fish farming, *Fish management, *Fish harvest**
**Identifiers: *Recirculation raceway system, *Two-crop fish production, Water reservoir, Intake screens**

The study was an evaluation of cultural practices used in producing catfish in recirculation raceway systems. This study is still being carried on as additional facilities are added to the fish culture research facility at the Coastal Plain Experiment Station at Tifton, Georgia. The system layout is a closed-loop or recirculation system, consisting of a water reservoir or pond, a deep drilled well, a 300 gpm centrifugal pump, 6-inch cement asbestos water distribution pipe lines, flow meter, raceway, raceway inlet and raceway segments. Accessibility to the fish for carrying out feeding, sampling, treating and harvesting operations is provided by the raceway and "pens". On the basis of one year's operation, this recirculation raceway system has proven to be an efficient and easily managed fish production system. However, there are some problems with the system. The major problem is maintaining water quality in a recirculation system that is used year after year. Further study is necessary to solve such problems and to keep the system economically practical. "Two-crop" fish production is one method of achieving this. (Kehl-East Central).

1996 - A1, B1, C1, D1, E1, F1, F2 200

## PROCESSING AND MANAGEMENT OF AGRICULTURAL WASTE

**Cornell University**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, [illegible], 1974, [illegible] p. [illegible] fig. [illegible] tab. [illegible] ref.**

**Descriptors: [illegible], Recycling**
**Identifiers: *Waste management, [illegible]**

The purpose of this conference was to provide rapid and wide dissemination of information that would permit agriculture to continue to produce and process adequate quantities of food without causing environmental problems. Emphasis was placed on federal effluent guidelines and their effect on the livestock industry, control of nonpoint diffuse pollution sources, and waste stabilization, treatment, and disposal. (Merryman-East Central).

1997 - A1, A2, A3, F3 200

## METHODS FOR IDENTIFYING AND EVALUATING THE NATURE AND EXTENT OF NONPOINT SOURCES OF POLLUTANTS FROM AGRICULTURE

Midwest Research Institute, 425 Volker Boulevard, Kansas City, Missouri 64110
A. Aleti, S. Y. Chiu, and A. D. McElroy
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 10-23. 1 fig. 4 tab. 31 ref.

Descriptors: *Agriculture, *Analytical techniques, *Mathematical models, *Measurement, Pollutants, Pollution control, Agricultural runoff
Identifiers: *Nonpoint pollution

Nonpoint pollution from agriculture has been found to consist of some mix on nutrients (nitrogen and phosphorus especially), organic biodegradable matter, microorganisms, pesticides, mineral salts and sediment. Runoff water is the principal carrier of nonpoint pollution. Sensible planning for control of pollutant emissions from agriculture and of water quality in surface and underground streams and reservoirs requires quantitative knowledge of pollutant loads as functions of several factors. Nonpoint pollution modelling may help achieve this. Many parameters are involved in specification of nonpoint pollutant generation. These include: Basic characteristics of the land, land use, pollutant generation, pollution control, transport mechanisms, and dynamic features of receiving bodies of water. While models exist which measure individual aspects of the problem, a comprehensive model to do all these things does not presently exist in usable documented form. The overall basic need is development of comprehensive models which: (1) include all significant pollutants, but can treat each individually; (2) are sensitive to the causes (sources) of pollution and thus can provide the means to develop and assess various pollution control measures and strategies; and (3) recognize interdependencies between pollutants, such as pesticides and sediment, in order to facilitate development of simplified control measures. (Merryman-East Central).

1998 - A1, B1, F1, F2, F3 200

## EFFLUENT REGULATIONS FOR LIVESTOCK AND POULTRY FEEDLOTS

Chief, Impact Analysis Section, Effluent Guidelines Division, Environmental Protection Agency, Washington, D.C.
J. D. Denit
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. [illegible]. [illegible] tab. [illegible] ref.

Descriptors: *Economics, *Legal aspects, *Regulation, *Wastes, *Livestock, *Feedlots, Effluents, Water pollution control
Identifiers: *Guidelines, *Environmental Protection Agency

The Federal Water Pollution Control Act, as amended in 1972, defines concentrated livestock and poultry growing operations (feedlots) as "point" sources of "industrial" pollutants and further requires that permits be issued for these operations. Until 1977, existing feedlot operations are to utilize [illegible] "in being" pollution abatement facilities. Conversely, new feedlot installations must mandatorily utilize the latest techniques. Only by 1983 is enforced adoption of updated level of technology demanded of the total industry. This is considered to be a "reasonable" approach because the statute seeks to control and abate water pollution without diminution of a vital industry which has been contributing to mounting pollution problems. By evolutionized, as opposed to immediate, demands the statutory goal can and will be achieved. In this reasonable process, the individual operator, upon whom the vitality of a clean, efficient industry ultimately depends, will more certainly grasp his indispensable role in abating pollution. (Merryman-East Central).

1999 - A2, B1, F1, F2 200

## THE ECONOMIC IMPACTS OF IMPOSING EPA EFFLUENT GUIDELINES ON THE U. S. FED-BEEF INDUSTRY

Agricultural Economists, Commodity Economics Division, Economic Research Service, East Lansing, Michigan
J. B. Johnson and G. A. Davis
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 59-70. 1 fig. 5 tab. 5 ref.

Descriptors: *Water pollution control, *Legal aspects, *Regulation, *Feedlots, *Cattle, *Economics
Identifiers: *Effluent guidelines, Environmental Protection Agency

The Federal Water Pollution Control Act Amendments of 1972 require that the discharge of pollutants into navigable waters be eliminated by 1985. Interim goals toward "zero" discharge are to be achieved by July 1, 1977, and by July 1, 1983. Effluent limitations for point source dischargers require the application of best practicable control technology currently available by 1977 and the application of the best available technology economically achievable by 1983. Thirty-five percent of those feedlots with dry-lot paved housing systems, because of their location in the Eastern States, are identified as having surface water control problems or potential. Twenty-six percent of these feedlots in the 18 states using open-lot [illegible] have surface water control problems or potential. Of feedlots with dry-lot unpaved housing systems, 23 percent either have existing surface water control problems or the potential for runoff problems during and subsequent to a local 10-year, 24-hour storm. Implementation of unrevised EPA effluent guidelines could result in annual cost of increases which would severely encumber the economic viability of smaller-sized fed-beef operations with land-extensive housing systems located in humid production regions. Some operations may cease production. All feedlots which take actions to control runoff can expect lower returns on investments if production is continued at historical production levels. Improvements over time will depend on changes in input prices and the value of beef marketed. (Merryman-East Central).

2000 - A2, B1, D1, E2 200

## IMPLICATIONS OF EFFLUENT GUIDELINES AND OTHER POLLUTION CONTROL MEASURES ON DAIRY FARMS

Assistant Professor of Agricultural Economics, Cornell University, Ithaca, New York
[illegible]
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. [illegible]. [illegible] tab. [illegible] ref.

Descriptors: *Dairy industry, *Effluents, *Agricultural runoff, *Economics
Identifiers: *Pollution control, *Guidelines, Legal aspects, Land spreading

Physical and economic consequences are considered for the following kinds of pollution control measures that could be imposed on dairies: (1) mandatory control of surface runoff at the barnyard; (2) prohibition of winter spreading of dairy wastes; and (3) mandatory subsurface disposal of dairy wastes. Linear programming and partial budgeting techniques were employed to analyze these waste handling systems: (1) Stanchion housing — Gutter cleaner-spreader-daily hauling; (2) Open lot housing — Scraper-loader-spreader-daily scraping of alleys and scraping and hauling from lots; (3) Cold covered housing — Scraper-loader-spreader-daily hauling; (4) Warm enclosed housing — Tractor scraper-underground storage-liquid spreader; Mechanical scraper-underground storage-liquid spreader; or slotted floor underground storage liquid spreader. It was determined that: (1) Runoff control would most likely apply to open lot housing; (2) Prohibition of winter spreading and mandatory subsurface disposal would apply to all four types; (3) Economic impacts of compliance with all three control measures would be the worst for stanchion housing. Cold covered housing systems would be least affected if 6 month solid storage was allowed; (4) For farms with 80 cows, warm enclosed housing and a liquid manure system, investments for a soil injector and for increasing underground storage capacity to 6 months would increase 3 percent and monetary returns would be reduced 11 percent. Added waste storage, if provided by less costly underground pump-outside storage system, would increase costs by $16 per cow and reduce operator returns by 16.7 percent. (Merryman-East Central).

2001 - A1, B1, B2 200

## COST OF REDUCING SURFACE WATER POLLUTION FROM U. S. DAIRY FARMS

Agricultural Economist, Commodity Economics Division, Economic Research Division, Economic Research Service, Minnesota University, St. Paul
B. M. Buxton and S. J. Ziegler
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. [illegible]. 1 fig. 5 tab.

Descriptors: *Costs, *Water pollution, *Dairy industry, *Waste storage
Identifiers: Land disposal, Runoff control

Representative-size farms in 5 regions of the United States were selected to estimate individual and annual costs to (1) control runoff from exposed lots and wash water from the milking area, and (2) provide manure storage to avoid disposal on frozen ground. Results indicated that the greatest financial impact of controlling surface water runoff would be on dairy producers with fewer than 20 cows. Investments in the runoff control facilities would be as much as $[illegible] per cow, with annual costs as high as $[illegible] per cow and milk production costs increasing by as much as $[illegible] per 100 pounds of milk. An additional investment of as much as $[illegible] per cow for operations in the northern region would result if winter manure disposal was prohibited. The impact of controlling surface water runoff on farms with 20 or more cows is significant, but not as dramatic as the impact on smaller dairy farms. Total investment for runoff control for United States dairy producers with a runoff problem would be about [illegible] million. By excluding producers with less than 20 cows, investments would be reduced to [illegible] million. If all herds with less than 100 cows were exempted, investment would drop sharply to [illegible] million. Investment in manure storage facilities would be as much as [illegible] million, but would drop to [illegible] million if herds with less than 100 cows were excluded from complying with winter manure disposal guidelines. [illegible] (Merryman-East Central).

2002 - A2, B1, F1, F2 200

### ECONOMIC IMPACT OF CONTROLLING SURFACE WATER RUNOFF FROM POINT SOURCES IN U.S. HOG PRODUCTION

**Agricultural Economist, Commodity Economics Division, Economic Research Service, U.S. Department of Agriculture**
**R. N. Van Arsdall**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 97-107.**

**Descriptors: *Economics, *Agricultural runoff, *Water pollution control, *Regulation**
**Identifiers: *Hog production**

This economic impact analysis is limited to examination of prevention of surface water pollution by contaminated runoff from concentrated systems of production. This analysis began before the announcement of the EPA's proposed effluent guidelines of September 7, 1973, but the conclusions are still pertinent. Hog production is largely in the hands of small volume production. Producers turning out fewer than 200 hogs a year make up a third of total production in the 15 major hog producing states. Thus strict runoff control regulations would very likely put many pork producers out of business due to excessive financial burden. The remaining hog producers then would have to take up the slack in hog production. They could do this only after a period of adjustment. In the meantime, these larger producers could probably make the needed changes without much increase in pork prices for the consumer. What would cause an increase in the price of pork is the shortage of pork during the adjustment period. Desirable outcome in the changes ahead would be augmented by the following: (1) Specifics of regulations and timing of their application should be made known as soon as possible; (2) Regulations should be phased into the industry over a period of years; (3) Most producers of moderate size may be able to absorb additional costs per 100 pounds of pork produced and to continue production on a competitive basis. However, many may not. Thus, there may be a need to allow more time for adjustment or to provide a cost-sharing to meet their needs. (Merryman-East Central).

2003 - A1, B1 200

### AN ENVIRONMENTAL ANALYSIS OF FEEDLOT SYSTEMS

**C. N. Ifeadi and W. T. Lawhon**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 108-121. 6 fig. 13 ref.**

**Descriptors: *Feedlots, *Systems analysis, *Environmental effects**
**Identifiers: *Pollution**

The purpose of this paper was to suggest a methodology whereby feedlot systems could be analyzed for potential environmental impacts. The balance between the constituents necessary for maximum production and the capacity of the environmental components to withstand pollution was analyzed. This was done by compiling a simple checklist, arranged in matrix form, and developed so that the potential interactions between the various components of the feedlot system and its environment could be identified. Feedlot systems and processes were listed with corresponding pollution impacts for (1) surface-water pollution, (2) groundwater pollution, (3) air pollution, (4) land pollution, and (5) aesthetic and human factors. Further studies will be required in order to develop data which will verify the simple mathematical models put forth in this paper and in order to determine the magnitude of the impacts shown in the matrix. (Merryman-East Central).

2004 - B3, D2, F1 200

### COMPLETE SYSTEM FOR COLLECTING, HANDLING, AIR-DRYING AND MACHINE DEHYDRATION OF POULTRY MANURE IN A CAGED LAYER PRODUCTION UNIT

**Department of Poultry Science, Michigan State University, East Lansing**
**C. J. Flegal, M. L. Esmay, J. B. Gerrish, J. E. Dixon, C. C. Sheppard, H. C. Zindel and T. S. Chang**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 122-131. 1 fig. 7 tab, 5 ref.**

**Descriptors: *Excetra, *Drying, *Economics, *Design**
**Identifiers: *Waste handling, *Caged layer production unit, Energy requirements**

This demonstration project was undertaken to design, construct and test a poultry laying house that would incorporate a complete system for waste removal, dehydration and refeeding to poultry and other livestock. Specific objectives were: (1) to demonstrate and evaluate a complete excreta handling system including in-house drying and dehydration, (2) to determine optimum dehydration conditions for the multiphase drying system, (3) to minimize energy requirements, (4) to make the system adaptable to most existing commercial egg producing units, (5) to determine emissions from the system, and (6) to determine the economics of the system. The project's clear span pole and truss building utilized a continuous conveyor belt drying tunnel and afterburner in drying the excreta. Fuel consumption, electrical inputs, air movement, and relative humidity were monitored. Different months yielded different results. In February the dryer reduced excreta moisture content to about 1 percent. Fuel consumption was between 2.45 and 2.83 gallons per hour for the dryer and 2.02-2.65 gallons per hour for the afterburner. The water removed by the dryer was 172-191 per hour (a BTU requirement of 2500-4500 Btu per lb. of water removed). Over half the fuel requirement was for the dryer; the rest was for the afterburner. Approximately 9 percent of the water was removed by ventilation, 3 percent in the tunnel, and 6 percent in the dryer. (Merryman-East Central).

2005 - B2, D1, E2 200

### INTEGRATED POULTRY-MANURE HANDLING USING FLUSH TRAYS UNDER CAGES AND RENOVATED WASTEWATER: AN IN-PROGRESS REPORT ON AN 1100-BIRD LAYER HOUSE

**Agricultural Engineering Department, Georgia Coastal Plain Equipment Station, Tifton**
**C. V. Booram, D. S. Bundy, G. B. Parker and R. L. Fehr**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 132-140. 5 fig. 2 tab, 15 ref.**

**Descriptors: *Poultry, *Excreta, *Hydraulic transportation, Sprinkler irrigation, Lagoons**
**Identifiers: *Waste recycling, Feathers, Aerobic lagoon, Land disposal**

Hydraulic handling of poultry manure is being tested at Iowa State University. Half of a 2200-bird laying house was renovated and is not operating as a flushing system. When the system is complete, aerobic-lagoon water will transport the manure. Temporarily, fresh water is being used. This modified system includes flushing tanks, flushing trays fabricated and formed from 12 gauge steel with an epoxy coating, and the necessary controls and equipment to process, treat, recycle, and dispose of manure and feathers. Wastes in the flushing channels are hydraulically transported to a chopper pump where they are chopped and recycled with the water for channel flushing. Periodically, the manure and feathers are discharged through a sewer line into the anaerobic cell of a two stage lagoon. Future waste-management plans include evaluation of odor reduction, labor reduction, and management problems. Different flushing and discharge intervals will be used to determine the optimum system management. (Merryman-East Central).

2006 - B1, C1 200

### CHARACTERIZATION OF WHITE LEGHORN MANURE

**Agricultural Engineering Department, Cornell University, Ithaca, New York**
**A. G. Hashimoto**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 141-152. 7 fig. 6 tab, 8 ref.**

**Descriptors: *Feeds, *Mortality, Moisture content**
**Identifiers: *White leghorns, *Manure, *Egg production, *Waste characteristics**

Laying hens were placed in conventional stair-step cages when about 21 weeks old to begin their laying cycle. They were removed after 11 or 12 months of egg production. Data on feed consumption, egg production and bird mortality were recorded in an attempt to determine the variations in production and characteristics of laying-hen manure as related to diet, feed consumption, bird age, and egg production. Diet consumed had significant influence on manure production. Hens fed the Practical (Basal) Diet, with no additives, 0.2 percent DL-Methionine, 0.2 percent choline chloride (70 percent), or both 0.2 percent DL-Methionine and 0.2 percent choline chloride (70 percent) produced 37 percent more manure and 43 percent more moisture than those fed the Random Sample Diet. This effect of diet would be a significant management constraint, especially for operations utilizing "dry" manure-handling systems. Mass balances of feed consumption and manure production showed that approximately 35 percent of the total solids, 30 percent of the volatile solids, 70 percent of the fixed solids, 35 percent of the COD, and 80 percent of the total nitrogen consumed were recovered in White Leghorn manure. (Merryman-East Central).

2007 - B1, C1 200

### THE PRODUCTION RATE AND COMPOSITION OF MANURE FROM GROWING TURKEYS

**Animal Sciences Department, Purdue University, West Lafayette, Indiana**
**J. G. Berry, A. L. Sutton and J. R. Carson**
**Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 153-158. 1 fig. 2 tab, 9 ref.**

**Descriptors: *Nutrients, *Analysis**
**Identifiers: *Manure, *Production rate, *Composition, *Turkeys**

The purpose of this study was to determine the amount and composition of manure produced by growing turkeys under current confinement management practices. Average daily production rate (wet basis) was determined to be 0.64 pounds per bird per day for the males and 0.53 pounds per bird per day for the females. Mean values of nutrients for all samples regardless of sex was determined by chemical analysis (wet basis). Nitrogen, phosphorus, and potassium were 1.36 percent, 0.49 percent, and 0.71 percent respectively. (Merryman-East Central).

2008 - A6, B1, C1 200

### AIRBORNE MICROORGANISMS IN HIGH DENSITY POULTRY MANAGEMENT SYSTEMS

Department of Food Science, Cornell University, Ithaca, New York
S. Sotiracopoulos and N. C. Dondero
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 159-174, 6 fig, 7 tab, 30 ref.

Descriptors: *Poultry, *Air pollution, *Microorganisms, Pathogenic bacteria
Identifiers: *Waste management, *Oxidation ditch, *Undercage drying pit, Staphylococcus aureus, Salmonella typhimurium

An investigation was undertaken to: (1) estimate the total number of microorganisms and staphylococcus aureus per ft3 of air in four chicken growth chambers, (2) Demonstrate the dispersal of microorganisms into the atmosphere of the chicken growth chamber (due to aerosal formation from the "oxidation ditch"), (3) identify the isolates from air samples, (4) estimate the number of staphylococcus aureus and salmonella in the wastewater of the "oxidation ditch", and (5) study the survival of staphylococcus aureus and salmonella typhimurium inoculated in the wastewater at the "oxidation ditch". The waste treatment systems used in the investigation were: oxidation ditch, diffused aeration ditch, undercage drying pit (with slot outlet), and undercage drying pit (high-rise). Specific results are tabulated. Density of microorganisms varied widely and the density was influenced by type of waste treatment system. It was found that the oxidation ditch dispersed the highest number of microorganisms in the air. (Merryman-East Central).

2009 - A2, A4, B1, E2 200

### EFFECTIVENESS OF NITROGEN CONTROL IN POULTRY WASTE MANAGEMENT AS ESTIMATED BY SIMULATION MODELING

Manitoba University, Winnipeg, Canada
D. D. Schulte, R. C. Loehr, D. A. Haith and D. R. Bouldin
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 180-199, 7 fig, 2 tab, 15 ref.

Descriptors: *Computer models, *Mathematical models, Poultry, Water pollution, Leaching, Agricultural runoff
Identifiers: *Nitrogen control, *Waste management, Land spreading

Nitrogen management on a hypothetical poultry farm was computer simulated and a comparison was made of nitrogen losses to ground and surface water resulting from various waste management policies. Utilization of the mathematical model revealed the following: (1) leaching of inorganic nitrogen from manured fields was reduced more at equivalent removal levels followed by high application rates than at lower disposal rates; (2) confinement of manure disposal to the time preceding planting (April 1-May 20) and rates of 250 kg/ha or less, and/or removal of the majority of inorganic nitrogen prior to spreading reduced the inorganic nitrogen levels in the soil at the onset of winter to approximately that remaining where no manure was applied. (Additional research is needed to verify this.); (3) residual inorganic nitrogen in the soil at the onset of winter was affected more by nitrogen removal prior to disposal than by the application rate; and (4) most of the nitrogen lost in runoff from manured fields due to rainstorms occurring between April 1 and November 30 was carried in water from one or two storms. Due to the variability of runoff occurrences, scheduling manure disposal at different times within this period will not reduce runoff losses consistently over a number of years. (Merryman-East Central).

2010 - A1, E2 200

### AN ECONOMIC ANALYSIS OF POLICIES TO CONTROL NUTRIENT AND SOIL LOSSES FROM A SMALL WATERSHED IN NEW YORK STATE

Department of Agricultural Economics, Cornell University, Ithaca, New York
W. R. Schaffer, J. J. Jacobs and G. L. Casler
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 200-210, 3 tab, 8 ref.

Descriptors: *Model studies, *Economics, *Water pollution control, Nutrients, New York
Identifiers: *Soil loss, Watershed, Effluent taxes, Fertilizer taxes

A watershed model was developed which incorporated both estimated losses of nitrogen, phosphorus, and soil and the costs to the farmers in reducing these losses. The following three policies for controlling losses and measuring the effect on farm income in the watershed were evaluated: (1) restrictions on losses; (2) effluent taxes; and (3) fertilizer taxes. Costs to farmers in using any of these methods would be substantial. While (1) and (2) would be hard to administer, (3) would most likely be ineffective in reducing the losses of pollutants. The model did not evaluate the possibility of reducing losses by methods other than changes in crop and livestock production. Further research is needed. (Merryman-East Central).

2011 - A1, B1, E2 200

### LAND DISPOSAL PARAMETERS FOR DAIRY MANURE

Agronomy Department, Cornell University, Ithaca, New York
P. J. Zwerman, S. D. Klausner and D. Ellis
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 211-221, 7 tab, 17 ref.

Descriptors: *Dairy industry, Nutrients, Sediment transport, Agricultural runoff
Identifiers: *Manure, *Land spreading, *Loading rates

Researchers wanted to ascertain the effect of winter spreading, spring plow down and summer topdress methods on resulting nutrient and sediment losses. Dairy manure was applied at loading rates of 15, 45, and 90 tons per acre on land used for continuous corn production. Two systems of soil management were used. Removal of all plant residues at harvest was denoted as poor management. Reincorporation of plant material into the soil was considered good management. The following conclusions were made: (1) The greatest nutrient loss results when cow manure is spread on top of melting snow that is situated on frozen soil. Manure spread on frozen soils and later covered by snow does not result in excessive losses; (2) Even under such extreme conditions, substantial reductions in losses can be produced by lowering the loading rate and/or improving the soil structure through soil management. Even when spreading under adverse weather conditions, a 2/3 reduction in nitrogen and phosphorus losses to the environment was achieved by maintaining soil structure by return of residues; (3) Hurricane Agnes — 6.84" rain — was the most effective means of moving sediment. These sediments were lower in nutrients than the runoff waters; and (4) A high-intensity storm of 2.45 inches in August, 1972, removed little sediment and few nutrients. It was felt that this was due to the protective action of the nearly fully grown corn crop. (Merryman-East Central).

2012 - A1, B1, E2, F1 200

### BEEF WASTE MANAGEMENT ECONOMICS FOR MINNESOTA FARMER-FEEDERS

Agricultural Economics Department, California State University, Fresno
C. L. Pherson
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 250-270, 1 fig, 13 tab, 13 ref.

Descriptors: *Minnesota, *Regulation, *Economics, *Costs, *Model studies
Identifiers: *Waste handling, Runoff control, Crop selection

This study was performed to develop a method for determining optimal farmer response to Minnesota pollution regulations. Objectives included determination of (1) direct and indirect costs of complying with regulations, (2) net return maximizing alternative systems, (3) optimal time schedules for waste handling, (4) marginal value or cost of beef wastes, and (5) effects of system choice on field crop selection and crop operation timing, and the effects of set-aside acres or rotating disposal field. It was found that a programming model could accomplish these goals. Specific figures are tabulated for various alternatives. Pollution control consultants should consider alternative waste handling-housing systems in terms of farm-feedlot profit before recommending runoff control structures on current facilities. (Merryman-East Central).

2013 - A1, B1, E2, F1 200

### ENERGY AND MONETARY COSTS FOR TWO BEEF CATTLE WASTE DISPOSAL SYSTEMS

Assistant Professor of Agricultural Engineering, VPI/SU, Blacksburg, Virginia
H. A. Hughes, J. B. Holtman and L. J. Conner
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 271-282, 9 fig, 4 ref.

Descriptors: *Energy, *Costs, *Waste disposal, *Liquid wastes, *Solid wastes, *Mathematical models

A method was presented for determining the cost of energy to produce beef. The method was explained by use of an example beef feeding farm. The two alternatives that were considered were liquid waste handling and solid waste handling. Analysis was carried out by using a mathematical model based on the 'energy structures' technique. This technique is based on the systems concept of a set of components interacting through mass and energy exchanges among themselves in the environment. Equivalent network models then describe the complete system. Evaluations include the determination of energy cost of beef production and material flows into, out of, and within the system. It was found that liquid waste handling required larger amounts of capital, fossil energy, and labor than similar systems using solid waste handling. However, solid waste handling had greater nutrient loss to the environment. (Merryman-East Central).

2014 - A1, B1 200

### INFLUENCE ON FEEDING SYSTEM, DIGESTIBILITY OF RATION AND PROPORTION OF CONCENTRATE CONSUMED ON THE QUANTITY AND QUALITY OF EXCRETA VOIDED BY LACTATING COWS

Animal Research Institute, Research Branch
Agriculture Canada, Ottawa, Ontario K1A 0C6
L. J. Fisher
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 283-290, 5 tab, 5 ref.

Descriptors: *Feeds, Moisture content, Nutrients
Identifiers: *Feeding systems, *Digestibility, *Excreta, *Lactating cows

The quantity and characteristics of the manure produced from various feeding systems should be stated with greater precision. In an attempt to provide more comprehensive information as to quantity, moisture content, and nitrogen content of excreta, the results of approximately 400 digestibility trials conducted with lactating cows are summarized. If the refinement of predicting manure characteristics is considered to be warranted, then computer capabilities should be sufficient to formulate that bulk of data into meaningful guidelines. (Merryman-East Central).

2015 - A5 200

## A PRACTICAL PORTABLE METHOD OF ODOR MEASUREMENT

University of Kiel, Germany
H. Mannebeck
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 291-294. 3 fig,

Identifiers: *Odor measurement, *Olfactometer

The difficulty in making valid odor measurement is discussed. Because odor is not definable as a physical dimension, subjective organoleptic procedures must be used in its measurement. A certain objectivity is made possible by using olfactometers. The olfactometer has mainly been developed and designed for judgement of odor from animal production farms including storage, treatment and hauling of liquid manure. Using this equipment, odor loaded air will be mixed with odorless air to such a degree that odor can just be distinguished. The amount of dilution is used as a measure for the intensity of the air. During the testing process, there is almost no acclimatization to the odor because of light odor intensities. Furthermore, regeneration of the sensitivity of the nose takes place between measurements. Errors in measurement that can occur are: (1) Errors in measurement and calibration during determination of flow volume. (2) Errors due to temperature decrease. (3) Errors due to so-called effect of refreshness. (4) Loss of odor loaded particles due to adhesian inside the instrument. (5) Errors due to adaption. (Merryman-East Central).

2016 - B2, D1, F1 200

## THE HANDLING AND TREATMENT OF MINK WASTES BY LIQUID AERATION

Monteco Environmental Management Associates, Montgomery, New York
A. C. Anthonisen and R. C. Loehr
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 295-308. 10 fig, 8 tab, 9 ref.

Descriptors: *Mink, *Design, Economics
Identifiers: *Waste handling, *Liquid aeration, *Oxidation ditch, Jet-Aero-Mix System, Odor control

Results of laboratory and full scale experiments indicated that liquid aeration was feasible for handling and treating wastes of mink raised in enclosed sheds. The study indicated that wastes from the confined mink could drop into an in-house oxidation ditch and that offensive odors could be eliminated. Treatment efficiencies indicated that the microorganisms within the mixed liquor could remove 46% TS, 93% TKN, and 97% BOD. Foaming occurred but was not considered a problem. Better design was found to be needed to reduce odor control costs. Clogged nozzles due to hair and straw was a problem when using the Jet-Aero-Mix system. Other aeration alternatives are available, but the concept of liquid aeration itself does appear to be a workable one. (Merryman-East Central).

2017 - A1, B1, F3 200

## EUROPEAN APPROACHES TO THE CONTROL OF WASTE POLLUTION PROBLEMS CAUSED BY AGRICULTURAL WASTES AND FERTILIZERS

Agricultural Engineer Non-Point Pollution Control Division, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D. C. 20460
W. C. LaVeille
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 320-335. 8 tab.

Descriptors: *Water pollution control, *Europe, *Fertilizers, Pesticides, Forest Management, Nutrients
Identifiers: *Agricultural wastes

A seminar was held in Vienna, Austria, during October, 1973, to discuss pollution of waters by agriculture and forestry. In general, the discussions paralleled conferences on similar topics held in this country. The major differences related to European agricultural practices themselves such as the relative scarcity of feedlot operations of a size comparable to those found in the United States and the generally higher proportion of European land used for intensive agricultural production. Experts found it difficult to quantify at the country or regional level the degree of water pollution due to livestock production because specialized literature was scarce and no in-depth studies of the problem as a whole could be found. Use of fertilizers and pesticides was also discussed. The seminar drafted and approved recommendations that programs be established to: (a) encourage farmers and foresters to use suitable methods to help minimize the transport of nutrients to water bodies; (b) monitor the effects of agricultural and silvicultural activities on the waters, for assessing the share of these activities in total water pollution and estimating future tendencies in the evolution of such pollution; (c) follow with attention the recent trends in the use of fertilizers in forestry in order to avoid that forestry should become a significant source of pollution by plant nutrients; (d) promote research on such problems as the rate of transfer of nutrients through the soil, taking into account the many factors on which this rate depends. (Merryman-East Central).

2018 - B3, E3, F1 200

## BEEF FEEDLOT WASTE IN RATIONS FOR BEEF CATTLE

Department of Animal Science, California State Polytechnic University, Pomona
T. W. Westing and B. Brandenberg
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 336-341. 8 tab, 3 ref.

Descriptors: *Cattle, *Diets, *Performance
Identifiers: *Refeeding, *Manure

To assess the feasibility of recycling beef feedlot wastes, a feeding trial was conducted comparing a typical feedlot ration with an experimental ration consisting of 14 percent composted beef waste. Thirty steers were test fed for 184 days. Average daily gain (kg), feed consumption (kg), feed conversion (kg), cost/kg gain (c), were 1.10, 8.66, 7.87, .7711; 1.11, 8.25, 7.43, .8440 for the waste added and control groups, respectively. The closeout on the beef waste group was $14.87 less per head for the total feeding period. No significant difference was found in carcass yield, quality, or taste for the two groups tested. (Merryman-East Central).

2019 - B1, C1, D1, E1 200

## THE EFFECT OF RATION ON MATERIAL HANDLING AND PROCESSING METHODS OF BEEF CATTLE MANURE

Agricultural Engineers, Agricultural Research Service, U. S. Department of Agriculture, Nebraska University, Lincoln
C. B. Gilbertson, and J. A. Nienaber
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 342-355. 5 fig, 5 tab, 11 ref.

Descriptors: *Cattle, *Design, *Diets, Physical properties, Chemical properties, Biological properties
Identifiers: *Waste handling, *Manure, *Ration

The effects of three ration roughage contents on beef cattle wastes were determined in order to gather design information necessary for handling, conveying, and processing beef cattle wastes. The most significant effects of roughage content were on physical properties, production, total solids content, particle size, distribution, apparent viscosity, flow properties, compaction, and shrinkage factors. Volatile solids, specific gravity, and wet bulk density were least affected. Specific conclusions are stated. It was determined that the designing of waste management system components will depend on the changes in physical properties which are affected by ration roughage content. (Merryman-East Central).

2020 - A9, B2, D4, E3 200

## INFLUENCE OF INGESTION OF ANAEROBIC LAGOON EFFLUENT ON GROWING SWINE

John Deere and Co., Dubuque, Iowa
L. W. Schmitt, T. E. Hazen and R. J. Smith
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p, 356-374. 10 fig, 7 tab, 14 ref.

Descriptors: *Recycling, *Pathogens
Identifiers: *Anaerobic lagoon effluent, *Swine, *Ingestion, *Waste water

Because water may serve as a transport medium for many disease organisms, this study was concerned with the health of swine exposed to recycled lagoon effluent. An experiment was conducted which had three major variables: (1) animal exposure to the flush liquid, (2) type of flush liquid (fresh water or recycled anaerobic-lagoon water), and (3) the use of the two liquids in the drinking fountains. Also compared in the experiment were two swine feeding systems — on-floor and self-feeder. Overall, the experiment reinforced the belief that use of anaerobic-lagoon water in open-channel manure-handling systems does not degrade animal performance. Necropsy results showing degradation (hyperplasia) of the lymph nodes were not considered cause for alarm because the exposure to the lagoon water was extreme, since the pigs were forced to drink it as their only source of water. Future experimentation should include the following: (1) forced ingestion of recycled lagoon effluent during the full reproductive cycle, (2) injection of known enteric pathogens into the system, (3) use of more replicates to determine if feed efficiency is affected by ingestion of the gutter contents, (4) more detailed analysis of physiological changes such as white blood cell counts, antigen response, antibody titer, etc. and (5) evaluation of pulmonary irritation caused by gases. (Merryman-East Central).

2021 - B2, C5, D4, E3 200

## NUTRITIVE VALUE OF AMINO ACID PRODUCED IN AN OXIDATION DITCH FROM WASTE

Department of Animal Science,
Illinois University
B. G. Harmon and D. L. Day
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 375-381. 2 fig, 8 tab, 11 ref.

Descriptors: *Proteins, *Amino acids, *Feeds
Identifiers: *Swine, *Feces, *Oxidation ditch mixed liquor

Microbiota in intestines and excreted feces are very effective in bio-upgrading nitrogen containing byproducts and endproducts of metabolism into single cell proteins and amino acids. The oxidation ditch provides a compact, economical, and efficient system in which this bioenhancement may take place. The amino-acid rich product may then be used as a supplement for swine diets, Feeding systems using oxidation ditch mixed liquor can utilize all the waste produced by swine. (Cameron-East Central).

2022 - B3, D4, E3 200

### BEEF OXIDATION DITCH SETTLED SOLIDS FED TO STEERS

Agricultural Engineer, NCR-ARS-USDA
R. O. Hegg, J. C. Meiske, R. E. Larson, and J. O. Moore
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 382-386. 3 tab.

Descriptors: *Feeds, *Cattle, *Solid wastes, Performance
Identifiers: *Refeeding, *Oxidation ditch

Research was conducted to determine the feeding value of solids recovered from an oxidation ditch and refed to finishing steers as part of a ration. Twenty Holsteins were randomly allotted to five lots of four steers each. Regular air-dry, shelled corn was used as the control ration, with two rations containing different ration of reclaimed solids and corn. Because reclaimed solids were wet rations, water was added to two of the control rations to give similar moisture content. The 84-day feeding trial revealed that feeding reclaimed solids will not have a significant effect on the average daily gain of finishing steers if fed at rates up to one part corn: two parts reclaimed solids from an oxidation ditch. The reclaimed solids had 63 to 85 percent of the feeding value of regular air-dry corn on a dry matter basis, Reclaiming solids and refeeding them seems feasible; but if the system is used in open feedlots in cold regions of the United States, freezing problems due to the moisture content of the feed can be expected. (Merryman-East Central).

2023 - B1, D4 200

### A FUNDAMENTAL APPROACH TO ANAEROBIC LAGOON ANALYSIS

Agricultural Engineering Department, Clemson University, Clemson, South Carolina
D. T. Hill and C. L. Barth
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 387-404. 13 fig, 7 tab, 18 ref.

Descriptors: *Mathematical models, *Analysis, *Design criteria
Identifiers: *Prediction, *Anaerobic lagoons, Swine

Operating parameters such as loading rates, detention times, and depth have been investigated without really considering—more basic operating characteristics. Because chemistry of the wastes, stoichiometry, dynamics, and kinetics as well as microbiology of the reactions are all fundamentally inherent in the process, a mathematical model was developed to interface all these fundamental characteristics in an attempt to provide basic understanding of the overall process. General trends for anaerobic lagoons treating swine wastes were predicted. Because the parameters for this study were based upon the literature concerning conventional anaerobic digestion processes, as opposed to kinetic parameters, errors may have occurred. The model was meant to be only a first approximation. Refinement of the model through further studies should provide better correlations. (Merryman-East Central).

2024 - B2, C5, D4 200

### TREATMENT OF BEEF WASTE BY A ROTATING BIOLOGICAL CONTACTOR

Agricultural Engineering Department, Minnesota University, St. Paul 55101
J. A, Moore, R. O. Hegg, and R. E. Larson
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 405-414. 5 fig, 3 tab, 5 ref.

Descriptors: *Aerobic treatment, *Liquid wastes, *Cattle, *Recycling, Effluent, Costs, Analysis
Identifiers: *Rotating Biological Contractor

A Bio-Disc for treatment of liquid beef waste in a closed recycling system was evaluated. The unit consisted of a series of discs mounted on a horizontal shaft and suspended over a semicircular tank. The discs rotated slowly with about half of their surface intermittently exposed to liquid and to air. An aerobic bio-mass developed and grew on the disc. The bio-mass consumed organic matter in the waste water and utilized oxygen from surrounding air to maintain aerobic conditions. The liquid waste flowed progressively through four states, and then into a clarifier section where settleable solids settled out. Effluent from the clarifier section then flowed to a wet well and was pumped to the elevated flush tanks to repeat the cycle. Sample analyses were made for: chemical oxygen demand, biochemical oxygen demand, total solids, total volatile solids, phosphorus, chloride, ammonium nitrogen, organic nitrogen and pH. The Rotating Biological Contactor (RBC) removed 18 pounds of $BOD_5$ per day when receiving a primary clarifier effluent averaging 6006 mg/l of $BOD_5$, COD, $PO_4$ and organic nitrogen concentrations were 3 times higher on the sludge than in the RBC effluent. The pH values of the sludge were the lowest of those samples taken. The TVS as a percent of TS averaged 86% for the sludge and 70 to 73% for all other samples. Crystalline buildup on the discs interfered with bacterial growth, Based upon a cost of 30c per square foot of surface area installed disc, as estimated by Autotrol, the initial and operating cost of the RBC will not allow its widespread application to high organic strength animal waste waters. (Merryman-East Central).

2025 - B2, C5, D4, E3 200

### WASTE TREATMENT WITH A PROTEIN BONUS

Bacteriology Division, School of Agriculture, Aberdeen, Scotland
K. Robinson
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p 415-420. 3 fig, 2 tab, 8 ref.

Descriptors: *Aerobic treatment, *Proteins, Nitrification, Denitrification, Sludge, Copper, Swine
Identifiers: *Oxidation ditch, Anaerobic lagoons, Loading rates, Refeeding, Nucleic acid

An oxidation ditch was filled with anaerobic lagoon supernatant in order to determine: (1) loading rates of an oxidation ditch treating supernatant from an anaerobic lagoon, (2) feasibility of controlled simultaneous nitrification-denitrification, and (3) yield and protein value of sludge produced during aerobic treatment. After the initial start-up period the ditch was operated on a cycle of no aeration for one hour to allow sludge settling and the removal of a volume of supernatant equivalent to the input, agitation during addition of lagoon liquor, no aeration for 4-5 hours to permit denitrification to this cycle was the removal of mixed liquor instead of settled supernatant for approximately one month. Lagoon, oxidation ditch, and final settling tank samples were examined for total and dissolved COD, pH, $NH_4+/-N$ $NO_2$-N, and $NO_3$-N as frequently as possible (usually daily). Measurement of other parameters were also made. Microbial sludge harvested by centrifugation from oxidation ditch mixed liquor was analyzed for KjN, total and available lysine. Experimental results demonstrated that loading based on volume was only satisfactory if quality of input remained the same. Sludge protein may be of value for refeeding; however, copper and nucleic acid content may make such refeeding unsuitable. Further research is needed. Estimates of yield were 1 kg dry solids/ 100 pigs. (Merryman-East Central)

2026 - B2, D4 200

### APPROACHES FOR THE CONTROL OF NITROGEN WITH AN OXIDATION DITCH

Department of Agricultural Engineering, Cornell University, Ithaca, New York
T. B. S. Prakasam, E. G. Srinath, A. C. Anthonisen, J. H. Martin, Jr., and R. C. Loehr
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 421-435. 5 fig, 10 tab, 14 ref.

Descriptors: *Nitrogen, *Control, Poultry
Identifiers: *Oxidation ditch, Odor control

A pilot scale oxidation ditch was used to demonstrate several approaches for controlling nitrogen in poultry wastes. The following models of operation were used: (1) continuous rotor operation without intentional wasting of mixed liquor, (2) maintenance of a solids equilibrium condition by intentionally wasting some mixed liquor and subjecting the remaining mixed liquor to intermittent denitrification, (3) maintenance of solids equilibrium and using a solids separation tank to settle the mixed liquor suspended solids and to denitrify the recycled effluent, and (4) intermittent periods of rotor aeration which permitted nitrification and denitrification. Results of the study indicated that as much as 70 percent of the input nitrogen to the oxidation ditch could be conserved and up to 90 percent of it could be removed, depending on the mode of operation chosen. The study also indicated that waste stabilization and odor control need not be sacrificed when controlling nitrogen. (Merryman-East Central).

2027 - B2, D4 200

### OXIDATION DITCH SYSTEM ANALYSIS AND FIELD EVALUATION OF THE AEROB-A-JET

Universitaet Bonn, Institute fuer Landtechnik, Nuss-Allee
D, Simons, D. D. Jones, and R. C. Dale
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 436-454. 3 fig, 3 tab, 39 ref.

Descriptors: *Analysis, *Design, *Aeration
Identifiers: *Oxidation ditch, *Aerob-A-Jet

A critical analysis was given of the oxidation ditch system and its current design practices in connection with various aeration devices. Treatment efficiency, heat production and conservation, and solids liquid separation were examined in relation to different oxidation ditch systems. A field evaluation of the Aerob-A-Jet revealed that certain modifications must be made before it will operate optimally. The following conclusions concerning oxidation ditch design were stated. (1) Oxidation ditches should use channel cross sections which optimize flow properties and therefore decrease energy requirements for circulation and mixing. (2) Biological oxidations in the ODML produce a great deal of heat which should be conserved with the use of the proper aeration device. This would help prevent freezing in cold weather and the lower viscosity would decrease energy requirements for circulation and mixing. (3) The separation of large solids from the ODML would greatly enhance waste treatment, lower energy requirements for aeration and circulation, and decrease the problem of final disposal of the waste. (4) Liquid circulation and aeration should be accomplished by separate devices for maximum efficiency. (5) A ditch Reynolds number of at least 10,000 should be maintained if maximum treatment efficiency is to be achieved. (Merryman-East Central).

2028 - A1, B2, C5, D4, E2 200

### AEROBIC STABILIZATION AND LAND DISPOSAL OF LIQUID SWINE MANURE

University of Kiel, Germany
U. Riemann
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 455-463. 6 fig, 3 tab,

Descriptors: *Aerobic treatment, *Swine, Fertilizers, Bacteria
Identifiers: *Land disposal

A plant for aerobic biological treatment of liquid swine manure was built at Kiel University in order to clarify the material for release into a water course. During the tests, the goal changed to deodorizing and pasteurizing the manure. The multi-step research plant consisted of two isolated aeration tanks and a flotation reactor with an adjustable foam overflow leading to a foam drying bed. The aeration tank had a second outlet leading the liquid to a three-chamber sedimentation tank. The plant utilized swine manure with 6-8 percent dry matter contents which was treated in a batch and partly in a continuous flow system. The decomposition efficiency of the plant averaged 40 percent. The foam drying bed did not operate successfully due to a thin gelatinous layer build-up. It was found that sedimentation of solids going with the liquid phase from the flotation tank continuously into and through the sedimentation tank, could not be arranged successfully. Batchwise treated manure became odor free after seven days of treatment and remained so for two weeks. The continuous flow systems had quicker results but required more equipment. Bacteriological investigations with salmonella bacteria indicated that the bacteria were dead within six hours of their introduction into the reactor at temperatures around 40 degrees C. Crop yield from land fertilized with treated manure and land fertilized with untreated manure was about the same. Aerated liquid manure caused less corrosion damage when spread on plants. Biological aerobic treatment of manure will result in longer manure hauling periods. (Merryman-East Central).

2029 - A1, B3, E2 200

### FORAGE AND GRAIN PRODUCTION FROM LAND USED FOR BEEF MANURE DISPOSAL

Agricultural Engineering Department, Texas A&M University, College Station
D. L. Reddell
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 464-483. 14 fig, 5 tab, 18 ref.

Descriptors: *Productivity
Identifiers: *Land disposal, *Deep plowing, *Application rates

A study was conducted at El Paso and Tulia, Texas to evaluate deep plowing of large amounts of manure into the land. At El Paso, manure was applied to Vinton fine sandy loam in April, 1970, at rates of 0, 672, 1345, and 2017 mtons/ha. The manure was deep plowed into the soil by using a 76-cm moldboard, a 46 cm moldboard, and a 69-cm trencher machine. At Tulia, manure was applied to Pullman clay loam at rates of 0, 22, 56, 112, 224, 336, and 672 mtons/ha in August, 1971, and February, 1973. In addition, manure was applied at rates of 1345 and 2017 mtons/ha in August, 1971, only. The 22, 56, and 112 mtons/ha plots were plowed 36 cm deep with conventional farm tractors and plows. The remaining plots were plowed with a 76-cm moldboard. Forage sorghum was grown on all the plots and crop yields and quality were evaluated. Experimental results indicated that sandy soils like those in the El Paso study might best benefit from manure applications of up to 672 mtons/ha. Total yields of corn and forage sorghum over the three year period indicated little advantage to deep plowing the manure. The 46-cm moldboard performed adequately and had an enormous economic advantage. Soil similar to that of Tulia could best benefit from manure applications of 224 mtons/ha or less. Both plant height and plant population were decreased with manure applications in excess of 224 mtons/ha. (Merryman-East Central).

2030 - A1, B1, E2 200

### CROP AND HAY LAND DISPOSAL AREAS FOR LIVESTOCK WASTES

Agricultural Engineer, U.S. Department of Agriculture, Morris, Minnesota
R. A. Young
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 484-492. 6 tab, 12 ref.

Descriptors: *Crop response, *Agricultural runoff, *Erosion, Nutrients, Weed control
Identifiers: *Land disposal, *Application rates

Tests were undertaken to study the effect of surface spreading animal wastes to cropland before the plants were tall enough to preclude travel over the fields. The first year fifteen field plots were established, five on each of three crops — corn, oats and alfalfa. For each crop, two plots received twelve tons per acre of solid dairy manure, two received 0.25 inch of liquid beef cattle manure, and one was a check plot on which no manure was applied. Manure was applied within thirty days after planting or within two weeks after the first alfalfa cutting. The second year, thirteen more corn plots and ten more alfalfa plots were listed. This time the manure was applied between the corn rows, precluding contact with the corn. The same application rates were used. In addition, four of the plots that had solid manure applied between the rows were cultivated immediately after cultivation. Simulated rainfall was used to generate runoff and soil loss. The following conclusions were made: (1) Direct contact of plants with manure burned the plants; (2) Manure applications between the rows increased the yields and prevented such burning; (3) Manure applications conserved soil and water; (4) Concentration of nutrients in runoff and soil was quite high, but the total loss of nutrients was not great due to reduction of soil loss and runoff; (5) Loss of nitrogen from surface spread plots through volatilization of ammonia was high; (6) Application of animal wastes to growing crops early in the season effectively helped control weeds. (Merryman-East Central).

2031 - A1, B2, E2 200

### EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFFLUENT ON CORN AND GRAIN SORGHUM

Department of Agricultural Engineering, Georgia Coastal Plain Experiment Station, Tifton
C. V. Booram, T. E. Loynachan, and J. K. Koelliker
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 493-502. 10 tab, 10 ref.

Descriptors: *Sprinkler irrigation, *Effects, *Lagoons, *Effluent, Corn, Grain sorghum
Identifiers: *Land disposal, Application rates

A study was initiated in 1971 to investigate the effect of anaerobically treated swine wastes on corn and grain sorghum. In 1972, grain sorghum was omitted. Anaerobic swine wastes were applied by sprinkler irrigation with the following objectives: (1) Investigate management necessary for liquid disposal on growing corn and grain sorghum by conventional equipment; (2) Evaluate the effect of the rate and time of application on corn and grain sorghum yields; (3) Evaluate any detrimental effects on corn and grain sorghum. Application of lagoon effluent increased leaf phosphorus and nitrogen in both corn and grain sorghum. Sodium and iron contents increased in corn leaves, and manganese, copper, and zinc contents increased in grain-sorghum leaves. Nutrient concentration in the plant tissue increased but not to a level that would cause problems if the entire plant were ensiled. The effluent had no significant effect on corn yield, but it had a significantly negative effect on grain sorghum yield with decreases up to 53 bushels per acre. Increasing amounts of effluent resulted in significantly increased value of extractable phosphorus and exchangeable potassium in the surface two inches of soil. Salt levels in the soil also increased, but leaching resulted in negligible accumulation. (Merryman-East Central).

2032 - A1, B2, E2 200

### EFFECT OF LIQUID SWINE WASTE APPLICATION ON SOIL CHEMICAL COMPOSITION

Purdue University, West Lafayette, Indiana
A. L. Sutton, D. W. Nelson, V. B. Mayrose and J. C. Nye
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 503-514. 3 fig, 5 tab, 21 ref.

Descriptors: *Liquid wastes, *Salts, *Soil chemical properties, Aerobic treatment, Nitrates, Phosphorus, Sodium, Soil profile
Identifiers: *Swine, Application rates, Anaerobic treatment, Oxidation ditch

A $2_3$x5 factorial arrangement of treatments in a randomized complete block design experiment was used to study the following treatments: effects of dietary salt content (0.2 percent, 0.5 percent), anaerobic and aerobic waste handling systems, and five application rates, (0, 45, 90, 134 mT/ha waste; inorganic fertilizer) on the recycling of swine wastes to a sandy loam and silty clay loam soil cropped to corn. It was found that: (1) No ammonium nitrogen or nitrate nitrogen accumulated in silty clay loam soil from swine waste application. (2) Nitrate nitrogen in sandy loam soil leached to lower depths after the first year of waste application but not after the second year of waste application. (3) Available phosphorus levels in both soils increased with increased waste application rates. (4) Exchangeable sodium content in both soils increased with increased waste application rates. (5) There was increased soil sodium concentration and decreased soil phosphorus concentration in the plots treated with waste from pigs fed the 0.5 percent salt diet compared to the plots treated with the waste from pigs fed the 0.2 percent salt diet. (6) Sodium accumulated through both soil profiles. (7) Application of liquid swine waste at the above rates did not adversely affect the chemical composition of the soil and did not adversely affect corn production. (Merryman-East Central).

2033 - A1, B2, C5, E2 200

### MANURE HOLDING POND SEALING STUDY

Agriculturalist, California State Water Resources Control Board
D. Baier, J. L. Meyer, and D. R. Nielsen
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 515-521. 4 fig, 3 tab.

Descriptors: *Seepage, *Nitrates, Total dissolved solids, Construction, Salts, Biochemical oxygen demand
Identifiers: *Manure, *Holding ponds, *Sealing

The purpose of this study was to determine the extent of water seepage through the bottom of waste holding ponds as a function of time following their construction and use, and concomitantly examine total dissolved solids (TDS) both in the pond and in the soil solution beneath the pond with special attention given to nitrates. Additionally, the fate of nitrates and other salts were evaluated when field-dried manure was applied as fertilizer. It was found that: (1) salt concentrations in dairy pond water increase in direct proportion to the pond's age; (2) after six months of use, the pond appeared to have self sealed; (3) anaerobic reduction of nitrate to $N_2$ gas (which then passes off to the atmosphere) and prevention of the mineralization of ammonia due to the paucity of oxygen kept nitrate content of the pond low; (4) BOD did not significantly change with depth in the ponds; (5) danger of nitrate pollution to land is reduced when such denitrified pond water is used on fields while land application of dry manures at 76 cubic meters per hectare per year was found to have great potential for groundwater pollution. (Merryman-East Central).

### 2034 - A1, B1, E3 200

### SOIL MODIFICATION FOR THE DISPOSAL OF DAIRY CATTLE WASTES

Department of Soil Science and Agricultural Engineering, California University, Riverside
A. C. Chang, P. F. Pratt, K. Aref, and D. C. Baier
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 522-532. 3 fig, 11 tab, 7 ref.

Descriptors: *Dairy industry, *Soil management, *Nitrates, *Salts
Identifiers: *Waste disposal, *Liquid wastes, *Impervious membrane

A field trial was conducted to test the feasibility of installing an impervious asphalt membrane thirty inches below soil surface for the disposal of liquid and solid dairy wastes. The solid waste was applied to the land just before each of two crop plantings. Wastewater was then applied by flood irrigation throughout the growing season. Results follow. (1) The impervious layer effectively prevented downward movement of the salt-latent leaching water and reduced nitrate by denitrification. Salts were concentrated in small amounts of drainage water and pumped out of the pump. (2) The barley and sorghum crops were seriously damaged by unfavorable soil conditions created by the asphalt membrane and by improper water management. (3) The unavailability of a reliable technique for installing the membrane and the damaging effect that this technique had on the crops negates any promising use of this system, but the author does feel that utilizing a natural water-restricting layer in the soil for waste disposal should be encouraged. (Merryman-East Central),

### 2035 - A5, B1, D1 200

### POSSIBLE WAYS OF ABATING THE NUISANCE OF SMELL CAUSED BY LIVESTOCK AND POULTRY FARMS

Institute for Farm Buildings,
Wageningen, Holland
A. A, Jongebreur and M. Van Geelen
Processing and Management of Agricultural Waste, Proceedings of the 1974 Cornell Agricultural Waste Management Conference, Rochester, New York, March 25-27, 1974, p. 533-540. 3 fig, 13 ref.

Descriptors: *Odor control, *Poultry, *Livestock, *Ozone, Economics
Identifiers: *Public Nuisance Act, *Swine, *Deodorants, *Air washers

It is practically impossible to completely eliminate the generation of odorous gases from animal producing units. The Public Nuisance Act has been responsible for many owners of piggeries and poultry houses trying to reduce such odors, however. Among the methods tried are the use of deodorants, ozone applications, and air washers. Because the components of the deodorants and their possible influence on both human beings and animals are not sufficiently known, a permit under the Public Nuisance Act to operate with the use of deodorants can be refused. Ozone application has been found to reduce smells of exhaust air from piggeries and poultry houses, but not from broiler houses. Since the influence of ozone on the organ of smell is not known and since even low concentrations may be harmful, this method of odor abatement is not considered satisfactory. Installation of air washers into the ventilation systems of animal production units has proved effective, but further research is needed for establishing suitable filling materials and economical types of encasement. (Merryman-East Central).

### 2036 - A5, B1, D2, E3 400

### PROFIT, TOO, IN MANURE FROM PLASTIC PENS

Poultry Science Department,
Pennsylvania State University
G. O. Bressler
Broiler Industry, p, 33, 36, August, 1972. 4 fig.

Descriptors: *Farm wastes, *Poultry, *Economics, *Waste treatment, *Recycling, *Drying, Odor, Moisture content
Identifiers: *Broiler breeders

High density housing for broiler breeders is increasing and the quantity of manure which is more highly concentrated and has a greater likelihood of offensive odors, is also increasing. The two-stage manure handling system developed at Penn State solves these problems. As part of the sloping floor housing system, the two-stage manure handling system is completely automatic and it is a good economic (as well as ecological) investment because the end product has marketable value. Stage 1 of the process drys the manure in two ways and reduces the moisture content from 75 percent to 35 percent. The two drying methods are: (1) Vertically mounted fans under the sloping floors; and (2) A stirring mechanism that automatically agitates the manure several times daily. Stage 2, drying of excreta in a commercial heater-dryer, reduces the moisture content down to 10 percent. Although the two-stage drying system costs $15 per ton, the end product easily brings twice as much from garden center and industrial users. (Kehl-East Central).

### 2037 - A5, B1, F2 400

### MANURE ODORS CAN LAND YOU IN COURT

Central Field Staff, Farm Journal
J. Russell
Farm Journal, Vol. 89, p. 19, August, 1965

Descriptors: *Odor, *Legal aspects, Urban development, Zoning
Identifiers: Livestock operations, Agreements, Licensing

Many times, when people are close to a livestock operation a clamor arises against farm odors. This can result in the closing of the livestock operation. Some suggestions to help head off trouble are given and discussed. They are: (1) Zoning. If enough farmers ask for it, a special agricultural zone which is off-limits to any other use can be established. But a warning is given to remain alert for public hearings at which "exceptions" and "variances" may be granted, (2) Licensing. In order to obtain a license for more than a specified number of head, certain housekeeping standards must be met. (3) Agreements which spell out how feeders can keep the city off their backs. Trouble can be headed off by dairymen and farmers by considering future urban developments. (Kehl-East Central).

### 2038 - E3 400

### POULTRY WASTE FOR CATFISH

Feedstuffs, Vol. 47, No. 2, p. 20-21, January 13, 1975

Descriptors: *Catfishes, *Diets, *Performance, Proteins
Identifiers: *Poultry waste, *Air-drying

Studies showed that air dried poultry waste fed to pond-cultured catfish as a component of the diet resulted in acceptable growth and conversion efficiency. Diets fed included a basic diet containing fish meal and poultry byproduct meal as sources of animal protein; a diet containing 25 percent air-dried poultry waste and sources of animal protein and a similar diet with no source of animal protein. Better weight gains resulted from the catfish consuming diets containing air-dried poultry waste. Taste evaluation revealed no significant differences. (Cameron-East Central).

### 2039 - D2, D4 300

### DEMONSTRATION OF WASTE DISPOSAL SYSTEM

Moore Engineering, Inc., Consulting Engineers, West Fargo, North Dakota
C. R. Moore
U.S, Environmental Protection Agency Report Number EPA-R2-73-245, May 1973, 50 p. 7 fig, 18 tab, 12 ref.

Descriptors: *Cattle, *Hogs, *Animal wastes, *Sheep, Chemical oxygen demand, Biochemical oxygen demand, Waste treatment, Settling basin, Nitrates, Groundwater, Feedlots
Identifiers: *Stockyards, *Hydrasieve, Sheyenne River, Truck washrack, Solids separation

Laboratory studies of livestock waste were conducted both before and after the construction of an enlarged settling basin, a hydrasieve at the truck washrack and a two cell waste stabilization pond. A determination of the effectiveness of these two systems and the application of them to feedlots and other livestock facilities in the area were the main objectives. The settling basin and hydrasieve were effective in removing solids and COD from the truck washrack waste. Reductions in COD, total, suspended, and settleable solids were 23.9, 14.8, 50 and 80 percent, respectively. DO increased 42.8 percent and total solids decreased 3 percent across the hydrasieve. This 3 percent consisted of straw and other floating debris which would not be removed at the stabilization pond. The effectiveness of the stabilization ponds were generally good. The $BOD_5$ of the final effluent was reduced 48.6 percent over that of the drainpipe which had drained directly into the Sheyenne River during previous years. (Moore-Moore Engineering, Inc.),

### 2040 - D3, F1 400

### PROCESSED EXCRETA POTENTIALLY NUTRITIONAL

Western Livestock Journal, Vol. 53, No. 11, p. 68, January, 1975. 2 fig.

Descriptors: *Cattle, *Feeds, *Proteins, *Recycling, Performance
Identifiers: *Excreta, *Refeeding

Whenever protein supplies such as soybean meal or urea are in short supply, protein from cattle excreta can be nutritionally beneficial in supplementing Corn Belt feedlot rations prior to the final month or two of finishing. The benefit from the protein in the excreta was seen in increased weight gains. Lower feed costs of gain is a favorable aspect of excreta-fed cattle when no charge is made for the excreta and processing of it through a silo. Health of the cattle in no way appeared to be adversely affected during 5½ months of feeding fermented excreta. Scientists say more research is needed before results obtained in experiments thus far can be recommended in cattle feeding practice. (Cameron-East Central).

### 2041 - A9, B1, D1 400

### THE MANY ASPECTS OF SANITATION IN POULTRY DISEASE CONTROL

DeKalb AgResearch, DeKalb, Illinois
D. Halvorson
Poultry Digest, Vol. 33, No. 387, p. 190-196, May 1974, 5 fig.

Descriptors: *Environmental sanitation, *Poultry, *Disinfection
Identifiers: *Disease prevention, Fumigation

Sanitation is the reduction of some organisms and the elimination of others. A discussion of a program to prevent disease outbreaks in poultry is presented. Three basic disease prevention methods are: (1) The eradication of the pathogen, (2) The reduction in numbers of pathogenic microorganisms, and (3) The opportunity to increase the resistance of the host. Sanitation should be considered in all phases of poultry breeding. The breeding stock should be selected from a clean flock and should be kept clean. An outline or program for the production of nest-clean hatch eggs should be drawn up. Dirty and cracked eggs should be separated at the breeder house and then the clean eggs should be fumigated after each gathering to kill surface bacteria before they penetrate the shell. Breed house construction plays a part in the sanitation of the house and the egg. A table comparing wire floor and litter floor houses is given. The hatchery should be clean to receive the sanitary eggs. A program of clean-up and disinfection of a house after the removal of the birds is also important. Removal of dust and droppings necessitates a washdown of the poultry house and equipment followed by disinfection. Sanitation as applied to feed is also discussed. Water sanitation depends mostly on the source and the means of cleaning and disinfecting the system. Ventilation dilutes disease organisms and plays a major role in air sanitation. (Kehl-East Central).

2042 - A1, B1, E2, F1 300

### THE IMPACT ON DAIRY FARM ORGANIZATION OF ALTERNATIVE MANURE DISPOSAL SYSTEMS. A METHOD OF ASSESSING THE COST OF ENVIRONMENTAL REGULATION

A. Muhammad, R. L. Christensen, and G. E. Frick
Research Bulletin Number 608, University of Massachusetts Agricultural Experiment Station, Amherst, Massachusetts, May 1974. 40 p. 24 tab, 17 ref.

Descriptors: *Dairy industry, *Costs, *Waste disposal, *Regulation, Water pollution, Nutrients, Fertilizers
Identifiers: *Linear models, Land disposal, Stacking systems

The economic impact is given for controlled use of commercial fertilizers and of alternative waste disposal systems on 25 dairy farms with small, medium, and large herd sizes from the 3 geographical dairy regions of Massachusetts. Also evaluated are alternative manure disposal systems and farm resource adjustments minimizing the cost of meeting manure disposal constraints on individual dairies. Stacking and liquid pollution control systems required additional capital expenditure of 2 to 3 times and 3 to 5 times respectively, when compared to daily spreading systems. The liquid systems caused greater reductions in farm income compared to stacking systems, with the opportunity cost larger on free stall dairies than on stanchion dairies. Manure disposal may be improved by avoiding confinement systems and by acquiring additional acreage for forage production. The inclusion of plowing operations with the stacking and liquid systems yielded about twice and one-third greater cost opportunity than systems not requiring immediate plowing. On small farms, disposal in conjunction with plowing would be preferred because the added value of nutrients exceeded the combined marginal cost of labor and plowing. Results indicated a trade-off relationship between dairy farm income and enhancement of water quality. Income levels of the dairy operations could be restored to previous levels by acquiring about 50 acres of cropland and seasonal labor of 15 hours per week on 100 cow and 50 cow farms and 40 hours per week on 212 cow farms. (Battles-East Central).

2043 - A1, B2, E2 300

### GUIDELINES FOR LAND DISPOSAL OF FEEDLOT LAGOON WATER

Kansas State University, Cooperative Extension Service, Manhattan
W. L. Powers, R. I. Herpich, L. S. Murphy, D. A. Whitney, H. L. Mandes, and G. W. Wallingford
Cooperative Extension Service Circular C-485, Kansas State University, Manhattan, June, 1973, 7 p. 9 fig, 2 tab, 1 ref.

Descriptors: *Feedlots, *Lagoons, *Kansas, *Soils, Sodium, Potassium, Salt, Alkali
Identifiers: *Guidelines, *Land disposal, *Electrical conductivity, Application rates

This publication provides guidelines for feedlot operators on how to dispose of lagoon water on agricultural lands in order to minimize the chance of reducing the land's productivity. Lagoon water may be pumped onto soil after being diluted and only if it has a low electrical conductivity. The feedlot operator should follow these steps when disposing of lagoon water on soil: (1) Have the lagoon and diluting water analyzed. (2) Determine the soil texture on the disposal site; (3) Examine the water test results to see if the sodium plus potassium content is high enough to disperse the soil, (4) Dilute the lagoon water and pump the water onto the disposal site; (5) Find the maximum amount of undiluted lagoon water that can be added to the soil, but apply undiluted lagoon water only as a last resort; (6) Have an annual salt-alkali test performed on the soil from the disposal site;(7) Seek professional advice if the proper dilution factor is not found. (Battles-East Central).

2044 - D4, F1 300

### LIQUID AEROBIC COMPOSTING OF CATTLE WASTES AND EVALUATION OF BY-PRODUCTS

Chino Basin Municipal Water District,
P. O. Box 697
Cucamonga, California
F. Grant, and F. Brommenschenkel, Jr.
Environmental Protection Agency Report Number, EPA-660/2-74-034, May 1974, 50 p. 2 fig, 16 tab, 36 ref.

Descriptors: Liquid wastes, *Cattle, *Aerobic treatment, *By-products, Economics, Biological oxygen demand, Chemical oxygen demand
Identifiers: *Composting, Volatile solids, Thermophilic reactor, Mesophilic reactor, Total dissolved solids

The study was undertaken to determine the technical and economic feasibility of treating dairy waste in a liquid state by a tandem thermophilic-mesophilic aerobic stabilization process, more commonly described as liquid composting. Experimental apparatus were set up at an operating dairy and a program was organized to study the process. The study showed that a large fraction of dairy manure is relatively resistant to rapid biological degradation even at thermophilic temperatures. Antithetical requirements of sufficient oxygen for maximum biological activity and minimum air flow to preclude the need for an external heat source could not be satisfied with the particular experimental aparatus when utilizing air as the oxygen source. Improved results were obtained with an oxygen-enriched air supply which pointed out the potential advantage of a pure oxygen system. Preliminary cost estimates for a liquid composting process to serve 500 cows were developed within the context of current dairy operation economics. The estimates showed that the process is considerably more costly than current, conventional, composting operations and that the cost of the process is substantially above levels which could be maintained by dairy operations. (Grant-Chino Basin Municipal Water District).

2045 - A5, B1 100

### CORRELATING ODOR INTENSITY INDEX AND ODOROUS COMPONENTS IN STORED DAIRY MANURE

Department of Agricultural Engineering,
Clemson University
Clemson, South Carolina
C. L. Barth, D. T. Hill, and L. B. Polkowski
Transactions of the ASAE, Vol. 17, No. 4, p. 742-744, July-August, 1974. 6 fig, 2 tab, 18 ref.

Descriptors: *Odor, *Dairy industry, Aeration, Volatile organic acid, Hydrogen sulfide, Ammonia
Identifiers: *Odor Intensity Index, *Threshold level

Four manure storage reactor units were initially filled to design depth with tap water while manure was added to the 11.3 liter units regularly and supernatant was removed to maintain a constant volume. Three of the units were aerated in the upper 8 to 17 in. of the supernatant while one unit received no aeration. Five levels of dilution of each 20 ml sample of reactor supernatant were collected to be presented to a panel of judges. The threshold level and Odor Intensity Index (OII), was established as that dilution level at which half the panelists correctly detected the odor. It was concluded that: (1) Of the three odorants involved, OII correlated best with volatile organic acid concentration, next best with hydrogen sulfide and poorest with ammonia. (2) The best two odorant relationships with OII were expressed by volatile organic acids and $NH_3$ while inclusion of $H_2S$ did little to improve the fit of the regression function. (Battles-East Central).

2046 - D4, E3 400

### BREAKTHROUGH IN THE FIGHT AGAINST POLLUTION

D. Braun
Farm Journal, Vol. 96, No. 12, p. 20-21, December, 1972. 3 fig.

Descriptors: *Thermophilic bacteria, *Waste treatment, *Waste disposal, *Recycling, Cattle, Costs, Odor
Identifiers: Pollution control

Two reputable companies have patented systems that use thermophilic bacteria (active at temperatures above 100 degrees) to dispose of animal wastes. De Laval Separator Co. introduced a system that digests about 95% of the manure solids in just a few days and the system takes no more space than the holding pen for a big milking parlor. The General Electric Co. is operating a pilot plant that turns manure from 100 head of feedlot cattle into high-protein material. The new systems promise to control pollution and do away with odors. Thermophilic bacteria digest some cellulose and lignin as they turn manure into carbon dioxide and water. They also kill pathogenic bacteria with the heat they generate. The remains can be stored and spread later without odor. (Cameron-East Central).

2047 - B1, D3, E3 100

### CONVERSION OF MANURE TO OIL BY CATALYTIC HYDROTREATING

Pittsburgh Energy Research Center, U. S. Department of the Interior, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, Pennsylvania 15213
Y. C. Fu, E. G. Illig, and S. J. Metlin
Environmental Science and Technology, Vol. 8, No. 8, p. 737-740, August, 1974. 3 fig, 6 tab.

Descriptors: *Recycling, *Oil, *Catalysts, *Hydrogen, *Sodium bicarbonate, Feeds
Identifiers: Catalytic hydrotreating, Cobalt malybdate

Bovine manure, like coal, can be hydrogenated and liquefied at elevated temperatures and pressures in the presence of a vehicle and a cobalt malybdate catalyst. A promising method of hydrotreating organic wastes using synthesis gas and a combination of cobalt malybdate-sodium carbonate catalyst is presented in this report. The oil produced at 380°C has a low oxygen content and a high heating value. Addition of sodium carbonate to the reaction mixture, when using synthesis gas, improves oil yield, reduces oil viscosity, and reduces hydrogen consumption. Manure with moisture contents up to about 35% was evaluated and found acceptable as feed stocks. The other feature of the process is that it requires no process water. (Cartmell-East Central).

2048 - A6, B1 400

### CONVENTIONAL, CONFINEMENT OR FLUME

E. W. Manthey
Feedlot Management, Vol. 16, No. 5, p. 9-13, 41-42, 44, 47, May, 1974. 10 fig, 1 tab,

Descriptors: *Confinement pens, *Flumes, *Costs, *Performance, Agricultural runoff, Ammonia, Fertilizers, Irrigation
Identifiers: *Slotted floors, *Waste management, Flushing

An interview dealing with how conventional feedlots, slotted floor systems and flume floor confinement systems compare is presented. The savings of the slotted floors over the conventional feedlot includes: less mileage on the feed truck, fewer cleaning costs, no need for sprinkling, and reduced labor. Also, the waste from the slotted floor system can be pumped inexpensively and used as a fertilizer. The flume floor system has to be hydraulically flushed twice a day. Some other disadvantages of the flume floor include: slipping of the cattle and cowboys, dirty cattle, and manure buildup. The slotted floor system has none of these problems but it and the flume floor both have the problem of ammonia. The ammonia in the slotted floor system can be controlled with a chemical, but there is no way to control it in the flume system. The cost of the flume system is lower than the slotted system, but the slotted system is preferred by the builder interviewed. (Cartmell-East Central).

2049 - C5, D4, E3 400

### MANURE-ROUGHAGE SILAGE FOR RUMINANTS

Poultry Digest, Vol. 34, No. 395, p. 27-28, January, 1975

Descriptors: *Silage, *Ruminants, *Nutrients, *Feeds, Nitrogen, Proteins, Fermentation
Identifiers: *Refeeding, *Manure, *Roughage

A manure dryer is not a logical investment for a small operator because of its cost. A silo used to store poultry manure mixed with dry roughage is likely to be an economically sound choice because ruminant animals can utilize the nonprotein nitrogen in poultry manure and dry roughage is usually available. There are many advantages to mixing instead of drying. First, the energy and labor usually needed in drying manure is not required. Second, the moisture in the manure raises the moisture content of the silage mixture to a desirable 50-60 percent level. The fermentation process produces a pathogen free product and is equal in feed value to alfalfa in protein and total digestible nutrients. The main disadvantage is that poultry manure loses nitrogen if it is compacted when putrefaction starts. Protein is also lost when this occurs. This can be prevented by stirring or blowing air over it or by mixing in roughage on a weekly basis and putting it in a silo. Wilted hay as roughage could be used in the spring and summer while stalks and straw could be available in the fall and winter. Mixing would take place as it is fed through a blower into the silo. Ration comparisons are discussed. The value of silage as a feedstuff is given. The FDA has not approved the use of poultry manure for feed but it has encouraged testing and further experiments. (Kehl-East Central).

2050 - D4, E3 500

### METHANE PRODUCTION FROM SWINE WASTE WITH SOLAR REACTOR

Department of Biological and Agricultural Engineering, North Carolina State University, Raleigh
R. Parker, F. Humenik, R. Holmes, and M. Overcash
Presented at 1974 Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-3033, 8 p. 2 fig, 6 ref.

Descriptors: *Methane, *Feasibility studies, Energy
Identifiers: *Swine, *Mesophilic solar reactors, *Thermophilic reactors, *Methane digestion

Methane digestors may help solve the problems of waste treatment and energy conservation by utilizing animal wastes that provide energy rich nitrogenous and carbonaceous compounds. The preliminary results for the operation of a mesophilic solar reactor without supplemental heating and a thermophilic unit heated from 130 F. to 155 F. are presented. The model methane reactors are treated as possible preliminary treatment devices for energy conservation before the discharge of reactor fluids to a lagoon with terminal land application of excess liquid. Methane gas as fuel is not as efficient as other more widely used sources but may have to be considered in the future because of its long range availability and production rates. (Kehl-East Central).

2051 - A1, B1, D1 100

### BROAD BASIN TERRACES FOR SLOPING CATTLE FEEDLOTS

Agricultural Engineer, U. S. Department of Agriculture, Lincoln, Nebraska
N. P. Swanson, J. C. Lorimor, L. N. Mielke
Transactions of the ASAE, Vol. 16, No. 4, p. 746-749, July-August, 1973

Descriptors: *Terraces, *Feedlots, *Design, *Waste storage, *Waste disposal, *Agricultural runoff, Erosion control, Solid wastes, Slopes, Effluent, Nitrates, Cattle
Identifiers: *Broad basin terraces

Broad basin terraces in Nebraska cattle feedlots were developed to control erosion, restrict scouring and movement of solids by runoff, provide storage for runoff, and permit retention of solids in the feedlot for removal. A single basin was constructed in July, 1969, near Omaha with a 15 percent slope, a 448 ft overall slope length and a basin storage capacity adequate for a year's runoff. Experience revealed that 340 ft is the maximum slope length recommended for a 15 percent slope. A series of three terraces was constructed on a feedlot site near Springfield, Nebraska with an average slope of 7 percent. Basins were installed with slope lengths averaging 100, 150, and 170 ft. from the top to the bottom of the terrace where underground pipelines delivered the effluent by gravity to a holding pond. The longer and steeper slope length above the lower basin was too long; solids collection during 2 years averaged 0.6 cu. yd. per animal per yr. compared to 0.5 and 1.1 for the middle and highest basins. The basin bottom should be flat with a minimum width of 10 to 12 ft. to aid solids removal with a tractor mounted front-end loader; the bottom area of the basin should be large enough to prevent accumulated solids depths in excess of 6 to 8 inches in the intervals between cleanings. Design depth for temporary water storage in a basin should not exceed a safe depth for the size animals stocked in the feedlot. A manure cover over the feedlot will provide protection from nitrate pollution of groundwater and water erosion. (Battles-East Central).

2052 - B1 600

### CONSTANT RATE DRYING OF CHICKEN EXCRETA

Agricultural Engineering Department, Idaho University, Moscow
G. D. Wells, M. L. Esmay, and F. W. Bakker-Arkema
Presented at 66th Annual Meeting, American Society of Agricultural Engineers, Kentucky University, Lexington, June 17-20, 1973, Paper No. 73-409, 17 p. 4 fig, 2 tab, 7 ref.

Descriptors: *Poultry, *Drying
Identifiers: *Excreta, *Drying rates

The purpose of this research was to determine quantitive drying rates for chicken excreta under moderate environmental conditions found in poultry houses. The following two conclusions were supported by this research dealing with drying of chicken excreta in thin layers of less than 1 cm (½ inch). 1. The initial drying rate of fresh chicken excreta is constant. Falling rate drying periods follow the constant rate period. 2. The constant rate is a function of the boundary layer thickness and boundary layer concentration gradients with the surface at saturated conditions. (Cartmell-East Central).

2053 - E3 300

### SWINE WASTE AS NUTRIENT SOURCE FOR FINISHING PIGS

Department of Animal Husbandry,
Michigan State University,
East Lansing
D. E. Orr
Research Report 232, Report of Swine Research 1973, Agricultural Experiment Station, Michigan State University, East Lansing, September, 1973, p. 81-87. 1 fig, 12 tab,

Descriptors: *Feeds, *Nutrients, *Performance, Amino acids, Digestion
Identifiers: *Swine, *Oxidation ditch liquor, *Dried swine feces

With an increase in swine production, special consideration has been demanded by the problems associated with waste handling and odor control. An approach to these problems has been the operation of an oxidation ditch containing a paddle wheel which incorporates oxygen into liquid swine wastes for the purpose of promoting aerobic microbial activity and reducing odors. A study to evaluate the oxidation ditch liquor (ODL) as a source of nutrients in swine finisher diets was designed. Tables showing the nutrient composition, amino acid composition, digestion trial diets and their results for dried swine feces (DSF) and ODL diets were given. The study showed that finishing pigs will consume normal intake levels of corn-soy diets containing up to 22% DSF. When DSF is incorporated into corn-soy diets to replace a portion of the soybean meal, the rate and efficiency of gain are depressed. Performance from these diets can probably be improved by the addition of supplemental energy to diets containing DSF. The incorporation of DSF into a finisher diet resulted in a depression of apparent digestibility of dry matter, protein and energy. Pigs receiving ODL in their diet showed no improvement in performance. ODL diets resulted in lower apparent digestibility coefficients for dry matter, protein and energy in digestion trials. (Kehl-East Central).

2054 - A1, D1, E3 300

### PROFITABLE USE OF POULTRY MANURE

The Pennsylvania State University,
College of Agriculture, Extension Service,
University Park, Pennsylvania
W. W. Hinish and H. C. Jordan
Special Circular 146, The Pennsylvania State University, College of Agriculture, Extension Service, University Park, 4 p, 1 fig, 3 tab.

Descriptors: *Waste treatment, *Waste disposal, *Poultry, *Nutrients, Moisture content, Marketing, Litter
Identifiers: Pollution

A discussion of poultry manure, its plant nutrient content, moisture content, weight per bushel and its economic value is given. Within the first year after application, essentially all of the plant nutrients in poultry manure are available to plants. However, up to two thirds of the nitrogen can be easily lost. Three ways in which nitrogen losses through fermentation can be reduced are by use of: (1) ventilated, well-insulated houses; (2) litter materials which will rapidly dry the manure; and, (3) superphosphate to reduce gaseous loss of nitrogen as ammonia. Additional information concerning the above methods is given. A table showing application rates of poultry manure for various crops is given. Marketing of the poultry manure is examined in relationship to season, common wholesale outlets, pellet size, the cost of pelleting manure, general demand for bagged manure and pollution. Two common problems of manure, burning of plants and odor, are discussed. Five ways to insure increased retail and wholesale business were suggested. They are: (1) Dry manure as it is produced; (2) Have nitrogen, phosphorus and potassium tests run on samples from manure you are planning to sell; (3) Advise the buyer of definite application rates; (4) Advise the buyer on methods of application; and (5) Tell the customer that manure should be stored in a cool, dry place. (Kehl-East Central).

2055 - B2, D3, E2 400

### THEY PLAN TO EXPORT LIQUID MANURE TO THE ARABS

**Hoard's Dairyman, Vol. 120, No. 3, p. 188-189. February 10, 1975**

**Descriptors: *Liquid wastes, *Export, Fertilizers, Nitrogen, Phosphorus, Potassium**
**Identifiers: *Deodorizer, *Persian Gulf Countries**

Liquid manure may become a new export because of the fertilizer shortage and the food crisis. If this comes to pass, it will be because of the development five years ago of a compound that inhibits the growth of odor-producing bacteria and prevents swelling. The compound is "Nature's Own Deodorizer" and has been sold to dairymen for treatment of their liquid manure. Handling rights for the deodorant are held by Richard J. Briggs, Woodbury, Tennessee, who granted franchises to 40 dairymen from 40 states. The stabilized waste was shown by a Louisiana export broker to Mideast customers who saw the potential of utilizing returning tankers for importing organic matter and fertilizer nutrients for their unproductive, sandy soils. Six small Persian Gulf countries are included. Working through the dairymen to whom he sold franchises, Briggs is contracting for liquid manure to export. The contract would require the dairyman to supply an agreed-upon amount of manure each month and the manure must contain at least 0.2% each of nitrogen, phosphorus, and potassium. University tests have shown that meeting these requirements, particularly the phosphorus level, may be difficult. Contract requirements and the responsibilities of both the supplier and buyer are discussed. The liquid manure will cost more than the current fertilizer prices. However, the organic matter in the liquid manure has some additional value. (Kehl-East Central).

2056 - B1, D2, E2, E3 400

### MILK PLUS MANURE — HIGHER DAIRY PROFITS

**J. Hudson**
**Progressive Farmer, Vol. 90, No. 2, p. 90-91, February, 1975, 1 fig.**

**Descriptors: *Separation techniques, *Dairy industry, *Liquid wastes, *Solid wastes, *Feeds, *Nutrients, *Fertilizers, *Peat, Lagoons**
**Identifiers: Bedding, Shelf life, Preservatives**

Solid wastes from dairy livestock are being used for commercial fertilizers. Weathers Farms, Inc., Bowman, South Carolina, have developed a profitable system for collecting wastes, separating the liquid wastes from the solid wastes and storing the solid wastes. This simple system flushes any wastes in the alley into a holding tank. The liquid manure is pumped to a separator where the liquid waste is extracted leaving a moist manure. A conveyor belt carries the moist manure to a large concrete slab where it is either picked up by a peat company or used by Weathers Farms as bedding in their free stalls. The liquid waste is transported to either a lagoon or an irrigation system. North Carolina State University researchers have determined that these liquid wastes contain 80 percent of the nitrogen, some phosphorus and all the potassium that was in the solid waste; therefore, it is valuable as a fertilizer. Dr. William L. Johnson, assistant professor of animal science at North Carolina State University, mixes solid manure with corn silage and feeds this to steers and heifers with good results. The mixture, he states, is a good fiber source. Dr. Johnson discovered that screened manure will ferment if left in the sun for several days and will be rejected by livestock under these conditions. Dr. Johnson and associates are working on a special preservative to increase the shelf life of the manure. Advice on construction of such systems is given. (Kehl-East Central).

2057 - A1, B1, D4, E2, E3, F2 100

### ANTIPOLLUTION LAWS FORCE LIVESTOCK MEN TO DEVISE WAYS TO COLLECT, USE MANURE

**Staff Report of The Wall Street Journal**
**R. E. Winter**
**The Wall Street Journal, Vol. 53, No. 44, p 30, March 5, 1974**

**Descriptors: *Legal aspects, *Recycling, *Fertilizers, *Methane, Dehydration**
**Identifiers: *Manure, *Refeeding, Pollution**

Officials at Ohio Feed Lot Inc. have developed an enclosed system that converts cattle manure into garden fertilizer. About 16,000 head of beef cattle housed in eight metal barns are placed in pens bedded with free wastes obtained from wood-products plants. Every two or three weeks tractor-mounted loaders clean out the pens and transport the mixture of waste and wood-products to another building where a system of fans and ducts blows air through the material, assisting bacteria in breaking it down. Later the by-product is packaged and sold in 50-pound bags as garden fertilizer. Other corporations have solved pollution problems by moving away from the cities, using methane from manure for energy, and dehydrating manure to make feed. (Battles-East Central).

2058 - A9, D1, E3 400

### POULTRY WASTES STUDIED FOR USE IN LIVESTOCK FEED

**Journal of the American Veterinary Medical Association, Vol. 163, No. 3, p. 214, August 1, 1973**

**Descriptors: *Feeds, *Livestock, *Performance, *Costs, *Safety, Proteins, Nutrients**
**Identifiers: *Refeeding, *Dehydrated poultry manure**

This article discusses the production of a crude protein supplement made from dehydrated poultry manure which costs less than conventional supplements. More research is needed to ensure the safety of this kind of feed before it can be recommended for dairy and beef cattle, sheep, and goats. Cows using this feed ate less silage and consequently produced less milk than did cows on a conventional diet. However, the savings from the cheaper dehydrated poultry manure would more than compensate for the income lost from lower milk production. Each 100 lb. of concentrate contains 32 lb. of dehydrated poultry manure and 68 lb, of cornmeal. The mixture is then made into pellets. (Solid Waste Information Retrieval System).

2059 - B3, D2, E3 100

### RECYCLING OF ORGANIC WASTES WITH PROCESSING SYSTEM THAT PRECISELY CONTROLS HEAT AND FLOW

**Industrial Heating, Vol. 39, No. 10, p. 1924-1929, October, 1972, 6 fig.**
**Descriptors: *Recycling, *Organic wastes, *Equipment, *Feeds, *Fertilizers, Protein**
This article discusses a Vero Beach, Florida, company which has developed a machine that can convert most types of organic waste material into useful feeds and fertilizers. This new type of heating unit incorporates Aeroflash pollution control systems. Application has been made for several patents on the machine and process. Aeroflash will process virtually any type of organic waste, including fish, crab, shrimp, and chicken wastes, manure and water weeds, in 6 to 8 sec. Bacteria are eliminated, but a high protein content is retained. The result is a finished product with very little odor and a shelf life of years. The heart of the machine is a control system that maintains the necessary heat-flow relationship. (Solid Waste Information Retrieval System).

2060 - A1, B1 700

### MASS TRANSFER FROM A PACKED BED TO A WELL STIRRED SOLUTION AND THE MEASUREMENT OF THE EFFECTIVE PSEUDO-DIFFUSIVITY OF COD IN FEEDLOT RUNOFF THROUGH A POROUS STRATUM

**S. K. Choi**
**MS Thesis, Department of Chemical Engineering, Kansas State University, 1969, 136 p. 27 fig, 11 tab, 24 ref,**

**Descriptors: *Feedlots, *Agricultural runoff, *Chemical oxygen demand, *Water pollution**
**Identifiers: Pseudo-diffusivity, Rate of transport, Porous stratum**

The purpose of this research was to investigate the rate of transport of COD through a porous stratum saturated by water such as the soil manure surface in a feedlot. The secondary purpose was to determine this diffusion coefficient experimentally. The average value of the effective pseudo-diffusivity of COD was found to be approximately 5.02 x 10$-_{6}$ cm$_2$/sec at a tempature of 25+/—2 degrees C. This corresponds to the pseudo-molecular diffusivity of COD in water of 7.10 x 10$-_{6}$ cm$_2$/sec. Since the effective pseudo-diffusivity of COD through the porous stratum saturated by water is small, organic matter which diffuses from the earth underneath the feedlot to the surface of the lot probably does not contribute appreciably to the pollution due to the feedlot runoff. As far as COD is concerned, the main contribution to the pollution due to the feedlot runoff is the manure suspension moving along with the runoff water. (Cartmell-East Central).

2061 - B2, D4 700

### BIOLOGICAL TREATMENT OF FEEDLOT RUNOFF

**Department of Civil Engineering, Nebraska University, Lincoln**
**M. V. O'Neal**
**MS Thesis, Department of Civil Engineering, Nebraska University, Lincoln, September, 1973, 52 p. 8 fig, 10 tab, 44 ref.**

**Descriptors: *Biological treatment, *Agricultural runoff, *Feedlots, Water quality, Cattle, Nitrates, Waste water treatment, Activated sludge, Nebraska, Flocculation, Pilot plants**
**Identifiers: Clarifiers**

The purpose of this study was to operate and evaluate the performance of a completely mixed activated sludge unit system. Performance was to be evaluated by comparison to parameters established in the laboratory studies and by ease of operation and maintenance under field conditions. Conclusions reached were: (1) Organic loading of 0.2 gm COD/gm mixed liquor suspended solids (MLSS) or less will minimize waste strength reduction. (2) The clarifier can effectively retain solids in the system. Effectiveness of sedimentation depends upon maintenance of a flocculant sludge and MLSS concentrations not exceeding 6,000 mg/1. (3) The unit is generally maintenance free and easy to operate. Periodic measurements of settled volume provide adequate control of MLSS. (4) Foaming can become quite severe and affect the system by removing solids. Thus, laboratory studies have concluded that the runoff is amenable to aerobic treatment and a field unit was designed applying the results of these studies in order to evaluate the success of such a system in pilot scale operation. The success and subsequent application of this system will depend on the economics involved and the degree of treatment attainable. (O'Neal-Nebraska University).

2062 - A1, B2, D4, E2 300

### MANAGEMENT OF DAIRY CATTLE WASTES BY THE DEEP AERATED LAGOON AND IRRIGATION ONTO SOILS AND PLANTS

Department of Agricultural Engineering,
Purdue University, Lafayette, Indiana
A. C. Dale, J. L. Halderson, J. R. Ogilvie, M. P. Douglas, A. C. Chang, and J. A. Lindley
Progress Report, Department of Agricultural Engineering, Purdue University, Lafayette, Indiana, 1971, 10 p, 5 fig, 5 ref.

Descriptors: *Dairy industry, *Aerated lagoons, *Analysis, Design, Irrigation, Nutrients
Identifiers: *Waste management

After preliminary field testing indicated the feasibility of an aerated lagoon and sprinkler irrigation system for management of dairy cattle manure, a full scale system has been installed at the Purdue Dairy Farm. Design criteria and operational characteristics are reported. The system is convenient and relatively odor free, does not involve a large amount of labor, is economically feasible, provides a place for storage during the winter months, conserves nutrients in the wastes, and minimizes pollution of surface and subsurface waters. (McQuitty, Barber-University of Alberta).

2063 - D2, E3 300

### COMBUSTION DISPOSAL OF MANURE WASTES AND UTILIZATION OF THE RESIDUE

Tuscaloosa Metallurgy Research Laboratory,
Tuscaloosa, Georgia
E. G. Davis, I. L. Feld, and J. H. Brown
U. S. Bureau of Mines Solid Waste Research Program Technical Progress Report — 46, January, 1972. 1 fig, 5 tab.

Descriptors: *Burning, *Waste disposal, *Fertilizers, Potassium, Phosphorus
Identifiers: *Combustion, Manure, Rotary kiln

Agricultural manure wastes were combusted in a fluid-bed reactor or a small rotary kiln as a method for disposal of this waste material. As much as 90 percent weight reduction and 85 percent volume reduction was obtained by burning the manures. Dry manure burning in the fluid-bed reactor was self-sustaining, whereas wet manure was both dried and burned in the heated rotary kiln. Heat balance estimations indicate that preheating would be required to dry the wet manure prior to burning in the fluid-bed reactor. However, the estimation indicated that no extra heat was needed in the process if the wet manure was predried with exhausted combustion gases before being fed to the fluid bed. The burned residues were pelletized and found suitable for use both as a potassium and phosphorus fertilizer and as a lime soil conditioner. (Davis, Feld, and Brown-Tuscaloosa Metallurgy Research Laboratory).

2064 - A1, B1, E2 100

### CORN SILAGE YIELD AND SOIL CHEMICAL PROPERTIES AS AFFECTED BY CATTLE FEEDLOT MANURE

USDA Southwestern Great Plains Research Center, Bushland, Texas
A. C. Mathers, and B. A. Stewart
Journal of Environmental Quality, Vol. 3, No. 2, April-June, 1974, p. 143-147. 6 fig, 7 tab, 15 ref.

Descriptors: *Soils, *Chemical properties, *Feedlots, *Cattle, Nitrogen, Organic matter, Conductance, Phosphorus
Identifiers: *Land disposal, *Application rates, *Yields

The objectives of this research were to determine the effects of various rates of manure on corn silage yields and to measure chemical residues remaining in the soil. The results showed that 224 metric tons/ha was applied, the nitrate content of the forage exceeded the maximum safe level. Nitrate accumulated in the soil with increasing rates of manure additions. Total nitrogen in the surface 30 cm of soil was markedly increased as a result of manure additions. However, there was only a small increase in the 30 to 60-cm depth, and no increase in the 60- to 90-cm depth. Sodium biocarbonate extractable phosphorus increased as the amounts of manure applied were increased. Extractable phosphorus was not increased below the plow layer indicating that measurable amounts of organic phosphates were not leached through the soil. Manure increased organic matter contents in the surface 15 cm of soil. To avoid salt damage to crops and excess nitrates in forage and soil, manure applications should not supply large excesses of nitrogen. (Cartmell-East Central).

2065 - B1, D2, D4, E2 400

### IDAHO FEEDER ENDS MANURE WORRY: ADOPTS TOTAL RECYCLING SYSTEMS

Beef Editor
P. D. Andre
Beef, Vol. 11, No. 4, p. 8, 10-11, December, 1974. 8 fig.

Descriptors: *Idaho, *Recycling, *Fertilizers, *Sprinkler irrigation, *Costs, *Performance, Liquid wastes, Solid wastes, Confinement pens, Separation tecnniques, Ammonia
Identifiers: *Waste management, *Refeeding

A confinement building with a waste recycling system is discussed. The building is 104 feet wide and slightly over 400 feet long and has a capacity of 2,200 based on 20 square feet per animal. Two rows of 45-feet wide pens extend the length of the building and are separated by feed bunks and the feed alley. In this system, the waste is scraped from pits and flows to a holding pit 40 yds from the building. The wastes are then agitated and pumped to a separation unit. The solids are composted and incorporated into a growing ration. The liquid portion is pumped through a sprinkler system to fertilize a nearby field. It was noted that weather and frequency of scraping were significant in ammonia release. There was no difference in animal performance when using this system as compared to conventional systems and there were fewer health problems. Under normal operation, one man can handle the cattle and the recycling system. Addition of the recycling unit added about 25 percent to the total cost of the system. (Cartmell-East Central).

2066 - A5, B2, E2, F1 400

### HOW IRRIGATION CAN BE USED TO HANDLE MANURE

R. E. Phillips and M. R. Peterson
Hoard's Dairyman, Vol. 119, No. 15, p. 902, August 10, 1974. 1 fig, 1 tab.

Descriptors: *Irrigation, *Waste disposal, *Costs, *Dairy industry, *Liquid wastes, *Sprinkler irrigation, *Surface irrigation, *Missouri, Lagoons, Odor, Labor, Agricultural runoff

Several Missouri dairymen are using irrigation systems to solve manure handling problems and to lower the chance of pollution. In Missouri, anaerobic lagoons are recommended for storage of liquid manure for irrigation systems. These systems are relatively economical to construct, can be mixed to handle outside yard runoff, are able to store milking parlor and milk room wastes, allow settling out of stones and other debris, and permit some decomposition of solid materials which lowers operational problems with sprinkler nozzles. A surface or sprinkled irrigation system should be chosen that is well-adapted to the topography, soil, and crop grown on the soil-plant filter. Surface irrigation systems are lower in cost, but need more labor and require flatter topography than sprinklers. Problems of irrigation disposal units are: (1) pump inlet screens clog with solids that accumulate in the storage lagoon, (2) liquid manure is hard on equipment, and (3) there is some odor. Cartmell-East Central).

2067 - A1, B3, C5, D2, E3 400

### DRIED POULTRY MANURE UTILIZATION

Dawe's Laboratories Inc., Chicago Heights, Illinois
W. K. Warden
Poultry Digest, Vol. 32, No. 378, p. 344-345, August, 1973. 1 tab.

Descriptors: *Recycling, *Poultry, *Management, *Water pollution, Waste disposal
Identifiers: *Dried poultry manure, *Refeeding, *Utilization, *Nutrient value, Energy value, Waste handling

Significant efforts have been made to try to solve the enormous problems created by manure accumulation caused by raising livestock or poultry in large numbers in confinement. Reports are given on a study aimed at one facet of this problem, recycling poultry manure through laying hens — its nutrient value, limitations and economic worth. Previous studies showed that up to 40 percent dried poultry manure could be fed to laying hens with no adverse effect on production and up to 10 percent with no depression in feed conversion. The metabolizable energy value, the chief limiting factor controlling the use of poultry manure as a recycled nutrient through birds, has been determined to be 300 kilocalories per pound of air dry feed. The outlook for using DPM recycled in feeds from 20 to 25 percent of poultry and ruminant appears to offer some promise of helping to resolve the water pollution problem, but additional outlets for use will have to be found to conquer the problem. (Cameron-East Central).

2068 - A1, B1, C3 600

### EFFECT OF A LIVESTOCK WINTERING OPERATION ON A WESTERN MOUNTAIN STREAM

Department of Agricultural Engineering,
Montana State University, Bozeman
C. M. Milne
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4058, 17 p. 2 fig, 9 tab,

Descriptors: *Streams, *Water pollution, *Bacteria, *Sampling, *Analysis, Agricultural runoff, Livestock, Chemical properties
Identifiers: *Confinement wintering operations, *Ion-specific electrode

A four year project was begun during the winter of 1970-71 to evaluate the impact of livestock confinement wintering operations on the quality of waters adjacent to such operations. The approach taken was to periodically sample stream flow at several points near a wintering operation for constituents which might indicate animal activity. Five stations were established for water sampling and quality measurement. Experimental procedure varied during the course of the project. In the first two years the basic analysis methods was the ion-specific electrode. During the third and fourth years of the project, emphasis was on laboratory bacteriological and chemical analysis. Study of the chemical data revealed that (1) the values obtained were basically calcium-magnesium-bicarbonate water, (2) chlorides showed increases in concentration, and (3) nitrogen and phosphorus-related nutrients were very low. Study of the bacteriological data showed that (1) where a large amount of dispersed animal activity occurred, but was fairly dispersed, little effect on the stream was noted, (2) where the greatest amount of concentrated livestock activity occurred and it was concentrated, bacterial infection increased, and (3) where little activity occurred, bacteria counts were significantly reduced by dilution or drying off. (Cameron-East Central).

2069 - A1, B2 100

## WINTER OPERATION OF A MODIFIED, OPEN-FRONT FINISHING HOUSE FOR SWINE

Air Quality Engineer,
Kansas State Department of Health
D. D. Snethen, C. K. Spillman, and R. H. Hines
Transactions of the ASAE, Vol, 17, No. 2, p. 364-365, March-April, 1974. 1 fig, 2 tab, 8 ref.

Descriptors: *Winter, *Design, Environment, Temperature, Performance, Radiant heat
Identifiers: *Swine, *Confinement buildings, *Oxidation ditch

Experiments were conducted at the growing and finishing unit at Kansas State University Swine Research facility to evaluate the effectiveness of modifications for improving winter performance of swine in an enclosed building and to characterize the thermal environment of that building. As originally constructed, the building was to be operated with an open front the year-round, but during the first winter of operation, freezing impaired operation of the oxidation ditch. The following fall the building was modified from an open front to a closed front and equipment was installed to record thermal data and animal performance during the three winters from 1968-1971. Conclusions revealed that in winter climates similar to that of Northern Kansas, swine performance will be improved by enclosing the facility and providing supplementary radiant heat. The floor and inside dry-bulb temperatures in the modified building will be nearly equal thus allowing oxidation pit operation during the winter, and possibly ventilation rate for moisture control can be reduced. (Battles-East Central).

2070 - A5, C3, E2 400

## USE OF ANIMAL WASTES AS A SOIL AMENDMENT

Agricultural Research Service,
U. S. Department of Agriculture,
Lincoln, Nebraska
T. M. McCalla
Journal of Soil and Water Conservation, Vol. 29, No. 5, p. 213-216, September-October, 1974. 3 fig, 3 tab, 22 ref.

Descriptors: *Animal wastes, *Fertilizers, *Cattle, *Nutrients, *Crops
Identifiers: *Swine, Yields

Beef and swine manure has become a resource, Rising fertilizer costs have made manure a desirable commodity due to its nutrient value. Manure contains the major fertilizer elements—nitrogen, phosphorus, potassium, and sulfur, as well as many trace elements. Application of manure to soil may improve fertility and soil structure but problems do exist — transportation costs, salt accumulation, nitrate pollution, unpleasant odors, metal toxicities, pathogen hazards, and application at rates exceeding crop requirements. These problems can be reduced or eliminated with proper management. (Battles-East Central).

2071 - D1, E3 400

## DUNG HO: FDA SETS REGS ON RECYCLED FEED

Western Livestock Journal, Vol. 53, No. 20, p, 20, February 25, 1975.

Descriptors: *Regulation, *Recycling, *Animal wastes, *Feeds, *Antibiotics
Identifiers: *Refeeding, DES, Sulfa drugs

According to FDA official, Dr. F. E. Sterner, proposed government regulations for reprocessed grain (recycled animal waste) are coming. Dr. Sterner stated that he believes regulations will require approval of both a facility and process for manure recycling. Sterner also stated that he expects FDA to propose regulations on antibiotics and sulfa drugs. He suggested that good manufacturing regulations for medicated feeds will be announced soon. Modification of DES Feeding regulations are not expected, (Battles-East Central).

2072 - D1, E3 600

## PYROLYTIC CONVERSION OF AGRICULTURAL WASTES TO FUELS

Engineering Experiment Station,
Georgia Institute of Technology,
Atlanta
J. A. Knight
Presented at the 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-5017, 25 p. 18 fig, 4 tab, 3 ref.

Descriptors: *Fuels, *Energy, *Design, Economics, Georgia, Costs, Oil, Gases
Identifiers: *Pyrolysis process, *Agricultural wastes, Cotton gin wastes, Wood wastes, Char

Agricultural wastes represent a potential source of energy, and the utilization of these wastes as energy sources would be of tremendous benefit to the agricultural interests of this country. The steady-flow, low temperature pyrolysis process developed at the Georgia Tech Engineering Experiment Station is capable of converting these wastes into clean burning fuels. The process has been developed from bench scale to a large scale demonstration facility capable of converting feed rates of 50 dry tons/day. This EES pyrolytic process offers a proven process at the commercial prototype stage for the utilization of agricultural wastes and lignocellulosic materials as energy sources. (Cameron-East Central).

2073 - B3, C5, D2 600

## DRYING PARAMETERS OF FORMED POULTRY EXCRETA

Canning Machinery Division,
FMC Corporation,
Hoopeston, Illinois
T. M. Midden, I. J. Ross, and H. E. Hamilton
Presented at 1972 Annual Meeting, American Society of Agricultural Engineers, Hot Springs, Arkansas, June 27-30, 1972, Paper No. 72-451, 21 p. 9 fig, 2 tab, 5 ref.

Descriptors: *Drying, *Poultry, *Temperature, Air, Equations
Identifiers: *Excreta, *Cylinders, *Crusting

A study was done of the drying characteristics of formed poultry excreta. Fully exposed drying equations were used to describe the drying of manure. A series of tests were conducted to predict the constants involved in using these equations. Fresh poultry manure was formed into long cylinders and air dried at temperatures in the range of 100 to 950 degrees F. The thin layer drying characteristics were determined in the temperature range of 100 to 220 degrees F and the crusting characteristics were determined at the higher temperatures. Some conclusions based on the analysis of the data and the results were: (1) The drying constant $k$ is a function of the diameter of the cylinders, (2) It is possible to form a stable manure cylinder by crusting with high temperature drying air, (3) Pellet crust is a function of both air temperature and time of exposure of air, and (4) The effect of temperature on the value of the thin layer drying constant for a particular diameter cylinder can be explained by an Arrhenius type equation of the form: $\ln k = a - b/T$. (Cameron-East Central).

2074 - B1, D2, D4, E3 600

## RECOVERING PROTEIN FROM ANIMAL WASTE

Agricultural Engineering Department,
Purdue University,
West Lafeyette, Indiana
J. C. Nye, A. C. Dale, T. W. Perry, R. B, Harrington, and E. J. Kirsch
Presented at 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-15, 1972, Paper No. 72-955, 18 p. 3 fig, 7 tab, 22 ref.

Descriptors: *Proteins, *Animal wastes, *Cattle, *Feeds, *Treatment, Separation techniques, Costs, Design, Recycling, Amino acids, Chemical oxygen demand, Biochemical oxygen demand
Identifiers: *Microbial food, *Batch culture, Procedures, Rats

This study evaluated the feasibility of growing microorganisms on manure as a source of protein for animal feed. The microbial protein product produced from dairy cattle waste was found to be a chemically adequate protein supplement as measured by the amino acid analysis. This biomass produce was harvested and fed to laboratory rats as 18 percent of their diet with no dilatory effect. The inability of rats to use this product as their only protein supplement indicated that more work is required to refine the process. The waste treatment-food synthesis system proposed is an economically feasible alternative for livestock operations. (Cameron-East Central).

2075 - D1, E3, F1 100

## FUEL FROM LIVESTOCK WASTES: AN ECONOMIC ANALYSIS

Extension Agricultural Engineer,
California University, Riverside
W. C. Fairbank
Agricultural Engineering, Vol. 55, No. 9, p. 20-23, September, 1974. 5 fig, 1 tab.

Descriptors: *Fuels, *Organic wastes, *Economics, *Costs, *Gases, Livestock, Anaerobic digestion, Methane, Municipal wastes
Identifiers: *Liquefication, *Hydrolysis

Environmentalists loudly proclaim that farmers could solve their energy problems if they would power their machines with bio-gas from organic waste. A multistage high-pressure pump with intercooling and a storage-transportation system would be necessary for methane liquefication to produce dung gas. The anaerobic dissociation of dry manure with heat produces a gas, a pyrolyzate, and a highly mineralized char. The process offers the stimulating possibility of producing a fuel gas, and at the same time, reducing the tonnage of solid waste going to dumps. Synthesis gas, hydrogasification and dung oil are thermo-chemical processes for dissociating carbon, hydrogen, nitrogen, and oxygen compounds and then recombining the constituents into desired molecules. They all start with a carbonaceous feedstock and yield a stable product quantified in energy units. Several great cities of the world are experimenting with heat recovery processes municipal incinerators. The margin of profit on these energy recovery processes is so slight, the economy of scale so great, the complexity of the processes and facilities so real, that only municipal or corporate industry is likely to amass the capital and technical resources needed. (Cartmell-East Central).

2076 - A1, B1 300

## BEEF FEEDLOTS — A POLLUTION PROBLEM?

ARS-USDA, AERD, Livestock Engineering and Farms Structures, Nebraska University,
Lincoln
C. B. Gilbertson
Proceedings of Agriculture and Pollution Seminar, University of Arizona, Tucson, February 19, 1971, EES Series Report No. 35, p. 18-29, 5 tab, 19 ref.

Descriptors: *Feedlots, *Management, *Water pollution, *Air pollution, *Waste disposal, Climates, Agricultural runoff, Chemical properties

The waste produced by the livestock feeding industry produces a pollution problem for management. The management of a feedlot is affected by physical characteristics of the feedlot, climatic conditions, animal size, animal density and the type of ration fed. Livestock wastes are potential pollutants of (a) surface water, (b) ground water, (c) air, and (d) aesthetic pollution. A discussion of each of these problems is given. The primary general problem in feedlot management is the need for acceptable practices for complete pollution free waste management schemes to replace waste disposal systems. An acceptance of an available method rather than research backed recommendations is the reason for the existing waste management practices. (Kehl-East Central).

2077 - A6, B1 300

### AIR POLLUTION AND AGRICULTURE

Department of Plant Pathology,
Arizona University, Tucson
R. L. Caldwell
Proceedings of Agriculture and Pollution Seminar, University of Arizona, Tucson, February 19, 1971 EES Series Report No. 35, p. 66-71, 19 ref.

Descriptors: *Agriculture, *Air pollution, *Arizona
Identifiers: *Pollutants, Sulfur dioxide, Peroxyacetyl nitrate, Ethylene

The relationship between agriculture and air pollution is discussed. Examples of agricultural operations' pollution are animal wastes, grain, feed, fiber and meat processing, forestry operations, pesticide drift, plowing, vehicular travel over unpaved roads, wind blown soil from bare land, aero-allergins (pollens) from a number of plants and the burning of crop residues. A definition of agricultural air pollution injury is given as any harmful effect, whether visible or not, to plant or animals. Injury is defined as damages when it is sufficient to cause an economic loss. Some major air pollutants are sulfur dioxide, peroxyacetyl nitrate, ozone, ethylene and nitrogen dioxide. Their effects on plants and their port of entry into an organism is described. Actions that can be taken to reduce air pollution damage are (1) breeding resistant plant varieties, and (2) chemical protection. The Arizona situation is briefly examined. (Kehl-East Central).

2078 - A1, B1 300

### WATER POLLUTION LAWS AND REGULATIONS

Department of Agricultural Economics,
College of Agriculture, Missouri University,
Columbia
C. G. McNabb and D. R. Levi
Science and Technology Guide, Missouri University Columbia Extension Division, May, 1969, 4 p.

Descriptors: *Water pollution, *Regulation, *Missouri, *Permits
Identifiers: *Civil courts, *Injunction, *Fines, *Water Pollution Board

Two approaches for resolution and prevention of the Missouri water pollution problem are (1) through the Water Pollution Board and (2) through the civil courts. In 1957 the Missouri Legislature established the Water Pollution Board, defined water pollution, and adopted a state water policy which the board must regulate. The board was authorized to take legal action against pollution in a number of ways—by fines, by tax bills, by authorization to the Attorney General to bring suit against violators, and by withholding construction permits when proposed waste treatment facilities are inadequate. A permit was to be required for any [illegible] to construct, install, or modify facilities for waste disposal which discharge wastes into waters of the state. A person causing pollution may be sued for (1) an injunction, (2) damages, or (3) both an injunction and damages as a civil remedy to temporaory or permanent nuisances. (Battles-East Central).

2079 - A5, D3 100

### ODOR CONTROL IN CATTLE FEED YARDS

Consulting Chemical Engineer,
San Marino, California
W. L. Faith
Air Pollution Control Association Journal, Vol. 14, p. 459-460, 1964

Descriptors: *Odor, *Mechanical control, Legal aspects, Spraying, Disposal, Control
Identifiers: *Feedlots, *Chemical control, Odor counteractants, Masking agents, Disinfectants, Potassium permanganate

This paper deals with the experimental odor control program initiated in 1961 at the Roy F. Benton Feed Yards in Walnut, California, after complaints were received from a nearby residential area. A variety of methods to reduce odor to an acceptable level have been tried with varying results. A highly satisfactory procedure is based on "good housekeeping" practices, frequent removal of fecal material, and abatement of residual odor by spraying the lots at designated intervals with a solution of potassium permanganate. Details of the method are discussed. (Christenbury-Iowa State).

2080 - A1, B1, F2 300

### A SUMMARY OF STATE REGULATIONS PERTAINING TO ANIMAL WASTE MANAGEMENT IN THE NORTH CENTRAL REGION OF THE UNITED STATES

Department of Agricultural Economics,
Michigan State University, East Lansing
L. J. Connor, J. B. Johnson, and C. R. Hoglund
Report No. 193, Department of Agricultural Economics, Michigan State University, May 1971, 25 p. 22 ref.

Descriptors: *Regulation, *Animal wastes, *Water pollution, *Air pollution, Economics
Identifiers: *Waste management, *North Central U. S.

The purpose of this report is to provide a summary of present and proposed State regulations pertaining to animal waste management in the North Central Region of the United States. The regulations reported are those in effect or being proposed as of April, 1971. Summary of Regulations of the following states are included: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. State water and Air pollution control agencies for these states are listed. The appropriate State Agencies should be contacted for more complete and detailed information. (Cartmell-East Central).

2081 - A1, B2, E2 600

### TRANSFORMATIONS OF SWINE WASTEWATER IN LABORATORY SOIL PROFILES

Department of Biological and Agricultural Engineering, North Carolina State University,
Raleigh
L. F. McEver, F. J. Humenik, M. R. Overcash and R. W. Skaggs
Presented at 67th Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, Paper No. 74-4025, 19 p. 8 fig. 5 tab. 9 ref.

Descriptors: *Soil profiles, *Laboratory tests, Percolation, Nitrogen, Nitrates, Chemical oxygen demand, Water table, Liquid wastes
Identifiers: *Swine, *Wastewater, *Loading rates

The major objective of this study was to investigate the transformations of swine waste lagoon effluent in packed and undisturbed Wagram soil columns with a shallow water table (36 inches). 70 percent of the wastewater nitrogen was converted to nitrate within the rooting zone (upper six inches) for loading rates of one and two inches per week with COD values ranging from '99 to 650 mg l. While the organic materials moved through the soil with the soil water, a reduction in concentration with increased depth was observed. The organic portion of the swine wastewater was essentially stabilized after one week of storage in the upper soil regions. Almost complete removal (greater than 90 percent) of COD and TOC was recorded for flow through the entire packed and undisturbed soil columns. Mass balances showed no losses in total nitrogen as the wastewater percolated through the soil columns. The low COD to nitrogen ratio of the pretreated wastewater and the preferential removal of organics with soil depth restricted the possibility of induced percolation of carbonaceous substrate to the water table for complete denitrification without supplemental organic addition. (Cartmell-East Central).

2082 - A1, B1 100

### WASTE ACCUMULATION ON A SELECTED DAIRY CORRAL AND ITS EFFECT ON THE NITRATE AND SALT OF THE UNDERLYING SOIL STRATA

A. C. Chang, D. C. Adriano, and P. E. Pratt
Journal of Environmental Quality, Vol. 2, No. 2, p. 233-237, April-June, 1973, 2 fig. 3 tab, 25 ref.

Descriptors: *Dairy industry, *Confinement pens, *Nitrates, *Salts, *Soil profile, *Leaching, Groundwater pollution
Identifiers: *Waste accumulation

The objective of this study was to characterize dairy waste accumulation and distribution patterns on the surface of a corral and to evaluate its effect on the nitrate and salt status of the underlying soil strata. Wastes produced to dairy cows on an unpaved earth corral tended to accumulate in a small area near the feed bunk and the water trough. Moisture content of the accumulated waste varied widely with most of the surface covered with relatively dry waste. Comparing raw wastes with stabilized wastes, the accumulated waste was biologically unstable and subject to decomposition when it was wetted. The waste distribution pattern on the corral surface did not influence the movement of chloride and organic matter into the soil profile. Heavy accumulation of wastes created an unfavorable condition for the formation of nitrate which reduced considerably the amount of nitrate that was subject to leaching. Future improvement or redesign of dairy wastes management should take these results into consideration in order to minimize groundwater pollution. (Cartmell-East Central).

2083 - A8, B1, E2 400

### DO MANURE STACKS ADD TO FLY CONTROL PROBLEMS?

Department of Entomology,
Wisconsin University
W. L. Gojmerac
Hoard's Dairyman, Vol. 116, p. 556, May 1971

Descriptors: *Breeding, *Dairy industry
Identifiers: *Fly control, *Manure stacks, Land spreading

A study was made of farms stacking manure. The object was to make a comparison of the fly situation between farms storing manure and those hauling regularly. A trained university student accompanied a number of dairy plant field men on their routine farm calls. He inspected each farm in a systematic fashion with reference to fly breeding only. Out of the 70 farms inspected, 31 had manure piles and 39 removed the manure regularly. It appeared that farms with manure piles did not have a more serious fly problem than those hauling regularly. On farms having manure stacking equipment, the barn cleaner apparently is run more frequently, keeping the gutters clean. Therefore, there was less fly breeding inside the barn. Little fly breeding was found on manure piles. The fly problem appears to be found in other places, such as gutters, mangers, and calf pens. (Cartmell- East Central).

2084 - A1, F2 100

## WATER AND WATERCOURSES: WATER POLLUTION LAWS AND THEIR ENFORCEMENT IN OKLAHOMA

**Oklahoma Law Review, Vol. 22, p. 317-344, 1969**

**Descriptors: *Water pollution, *Legal aspects, Identifiers: *Sources of pollution *Oklahoma**

**Water pollution control laws in Oklahoma are presented. A summary is offered of the various factors which determine the existence of pollution and influence the types of legal devices used to meet the pollution problem. Common-law private remedies and public administrative controls are discussed. Emphasis is upon the current state pollution control authority and the enforcement practices of the several state enforcement agencies. The character of the water resources relates to the quantity, quality, and availability of water for use. The major man-made causes of pollution are discharges from municipal sewage systems, runoff from agricultural activities, and the disposal of industrial wastes. Causes of water pollution in Oklahoma are listed as; the petroleum industry, other industry, agricultural sources, and municipal wastes. (Cartmell-East Central).**

2085 - A1, B1, C3, D1, E1, F1, F2
300

## DAIRY WASTE MANAGEMENT ALTERNATIVES

**North Carolina State University
Raleigh
B. L. Carlile, S. H. Dobson, L. B. Driggers, J. M. Falter, G. J. Kriz, et. al.
Cooperative Extension Work in Agriculture and Home Economics. North Carolina State University at Raleigh, 38 p. 4 fig. 15 tab,**

**Descriptors: *Liquid wastes, *Solid wastes, Agricultural runoff, Lagoons, Irrigation, Drying, Waste water disposal, Dairy industry, Chemical properties, Odor, Pests, Costs, Economics Identifiers: *Waste management, *Land spreading, Refeeding, Composting, Application rates**

**This bulletin is designed to help dairy producers meet environmental limitation problems in the most practical and economical way. The first section deals with alternative waste management systems and their various components. Also included are sections on storm runoff control and parlor and milkhouse waste water control. Requirements and methods are given for preventing feedlot runoff and milkhouse waste water from reaching surface waters. A utilization and land requirements section presents guidelines and examples of how much waste can be applied per acre. Odor control and pest control sections provide suggestions and methods for reducing odor and pest problems. An economics section gives cost data and contains a partial budget sheet so that comparisons between the alternative waste management systems can be made. (Cartmell-East Central).**

2086 - A2, B1 300

## HYDROLOGY AND CHARACTERISTICS OF FEEDLOT RUNOFF

**Agricultural Research Service,
USDA, Lincoln, Nebraska
N. P. Swanson
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 71-80. 2 fig. 12 ref.**

**Descriptors: *Hydrology, *Feedlots, *Agricultural runoff, *Soil profiles, Topography, Meteorology, Infiltration rates, Phosphorus, Ammonia, Watersheds, Climate**

**A potential hydrologic pollution problem of runoff from 51,000 acres of Great Plains' feedlots existed in January of 1971. Rate of delivery of such runoff to streams is related to topographic, meteorological, and hydraulic characteristics in the feedlot area. Study of the agricultural runoff in Nebraska yielded the following hydrologic generalizations: (1) infiltration of pollutants into the soil profile is insignificant or very slow once a manure pack is formed, (2) a local problem of underground water pollution exists, (3) one inch rainfall may be absorbed by the soil manure mixture without runoff, (4) solids losses may be less from a feedlot than from tilled bare soil but moderate rainfall increases initiate much higher solids loss and COD value per unit volume of runoff, (5) rainfall intensity and solids removal directly influence phosphorus removal, (6) ammonia-N and $NH_3$-N contents decrease with continuing precipitation, (7) snowmelt runoff contains more solids than rainfall runoff, (8) following a rainfall, feedlot runoff will start sooner, last longer, contain many more times the P, $NH_4$-N content, and require less time to reach the point of discharge than the discharge from adjacent croplands, and (9) ordinarily it is not necessary to design runoff control facilities within a watershed in relation to fish populations, livestock water sources, and similar resources is most important. (Battles-East Central).**

2087 - A6, B1, F1, F2 300

## DUST AND ODOR PROBLEMS OF THE FEEDLOT

**D.V.M. Montfort Feedlot Company,
Greeley, Colorado
J. Young
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 81-86. 7 ref.**

**Descriptors: *Odor, *Dust, *Feedlots, *Air pollution, Legal aspects, Neutralization, Economics Identifiers: Malodors**

**objectionable air pollution is grouped into four categories: (1) human health hazards, (2) animal and plant injury, (3) long-term modification of the earth's climate or ecology, and (4) offenses to persons, due to particulate matter. Air pollution from malodors is a major problem because no specific neutralization chemicals are available and cause-effect relationships are not fully understood. Feedlot malodors have never proven hazardous to human health but can be assumed objectionable when people complain about them. The relationship between the feedlot and the surrounding population can be improved by odor neutralization within feasible economic and application scales. Air pollution in the form of particulate matter or dust has two areas of concern: (1) animal health, and (2) as a public nuisance. Control can entail any one or a combination of mechanical or chemical means and will depend on water availability, available labor force, available source of used oil, etc., concentration rate of cattle in pens, climate, and housekeeping procedures. (Battles-East Central).**

2088 - A1, B1 300

## ANIMAL WASTE MANAGEMENT IMPLEMENTATIONS EXTENSION CONSIDERATIONS

**Regional Extension Specialist, Feedlot Waste Management, Oklahoma State University, Stillwater
M. D. Paine
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 87-90.**

**Descriptors: *Liquid wastes, *Solid wastes, *Feedlots, *Management, Communications, Transportation, Odor, Dust, Waste disposal Identifiers: *Southern Great Plains, Information sheets, Handbooks**

**The development of large commercial cattle feedlots has brought about the development of a new kind of livestock manager. Today such a manager is likely to be a graduate of an animal science department at a land grant university. Today's feedlot manager oversees a large staff, makes maximum use of communication and transportation, and is compelled to be innovative in handling problems. But the problems arising from large feedlots require additional assistance. In the Southern Great Plains, the ES-USDA, in cooperation with extension directors, allocated special need funds to an experimental project on feedlot waste management. Objectives of the project were: (1) To provide educational opportunities for feedlot managers to be kept up to date on research and cattle feeding developments, with emphasis on waste management; (2) to assist communication between cattle feeders and research agencies; (3) to provide timely and adequate information on social-legal developments. Three subject matter areas were given priority—odor and dust; liquid disposal; and solid waste disposal. Information sheets on these subjects were to be developed for distribution. A feedlot environmental handbook is also being developed to assist feedlot operators. (Battles-East Central).**

2089 - A1, B1, F2 300

## ANIMAL WASTE — REGULATORY CONSIDERATIONS

**Agricultural Engineer, Robert S. Kerr Environmental Research Laboatory, Environmental Protection Agency, Ada, Oklahoma
L. R. Shuyler
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 91-95. 1 tab, 3 ref.**

**Descriptors: *Water pollution, *Regulation, *Feedlots, *Permits
Identifiers: *Discharge, *Impact statements, *Zero discharge**

**On December 23, 1970, President Nixon issued Executive Order Number 11574 which directed the Army Corps of Engineers to issue discharge permits under the 1899 Rivers and Harbors Act. On May 25, 1971, EPA administrator William D. Ruckelshaus testified before the House Committee on Agriculture to outline the permit program's application to the confined feeding industry. He felt that the program should be limited to feedlots of 1000 or more animal units which discharge their wastes from a single point source. Permit applications were required to be filed by July 1, 1971 A ruling handed down by Judge Aubrey Robinson, Jr., ordered that environmental impact statements be filed for every permit issued. This rendered the permit program virtually useless due to the monumental manpower problem that the requirement for impact statements created. The ruling may eventually make more comprehensive and workable enforcement of Federal and State water quality standards a reality, however. The judge also expanded the definition of "non-navigable" streams to include streams large enough for recreational boating. Legislation now pending in Congress, in addition to providing funds for much needed expansion of research, development, and demonstration in agricultural pollution control, stipulates the national goal of "zero discharge" by 1985, and provides for clarification of the national permit program to be administered by the EPA. (Battles-East Central).**

2090 - A1, B1, D1, E2 300

## EUTROPHICATION IN THE GREAT PLAINS

**Oklahoma Cooperative Fishery Unit,
Oklahoma State University, Stillwater
R. C. Summerfelt
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 97-118. 5 tab, 42 ref.**

Descriptors: *Eutrophication, *Great Plains, *Water pollution, *Fertilizers, Feedlots, Nutrients, Irrigation, Agricultural runoff, Effluent, Discharge (Water), Drying, Incineration
Idenitifiers: *Winterkills, Pit disposal, Land disposal, Fish kills

In the Great Plains area of the United States, an increasing amount of fertilizer has been applied to croplands since 1950. Simultaneously, the percentage composition of nitrogen, phosphorus, and potassium in fertilizers has increased as has the method of irrigation, thus enriching the water systems and causing eutrophication and winterkills. Increased use of commercial fertilizer in this area between 1955 and 1969 has increased N, P, and K concentrations in water systems above the minimum critical level. Eutrophication and winterkills in the North Central States and nitrate nitrogen levels of 55 to 60 percent entering Decator Lake, Illinois originated from fertilizers. Runoff from feedlot production in Kansas accounted for 5 of 27 reported fish kills during 1964. This pollution could have been controlled by use of (1) direct pit disposal of solids, (2) aerobic decomposition followed by either land disposal or drying and incineration or (3) proper location of the feedlot. Environmental standards, public demand for cleanup, and national policy are all burdening the discharger to prove that the effluent is innocuous. State water quality standards require treatment and control of animal feedlot discharge, but advancements in prevention of eutrophication are dependent upon the extra costs involved. (Battles-East Central).

### 2091 - E3, F1 400

### RECYCLING POULTRY WASTE NOT FOR SMALL OPERATOR

Poultry Digest, Vol. 32, No. 378, p. 369, August, 1973

Descriptors: *Recycling, *Economics, *Costs, *Poultry
Identifiers: *Refeeding, *Dried poultry waste

An interagency task force studied the economic feasibility of using processed waste material in poultry rations. Flock sizes in the experiment were 10,000, 50,000 and 80,000 birds. Dried poultry manure was fed in test rations of 0, 12 ½ percent, and 25 percent. Feeding of DPM to a 10,000-layer operation was found to be uneconomical at any level. For the 50,000-layer flock, feeding at the 12 ½ percent level resulted in lower unit cost of 0.3 cents per dozen eggs. For the 80,000-bird flock, costs dropped 0.6 cents. Since about 97 percent of the country's layer operations have fewer than 10,000 birds, only a small group of producers could economically process poultry manure and feed it under today's conditions. (Cameron-East Central).

### 2092 - B2, D2, E2 100

### FARM EFFLUENT—ELECTRICAL DISPOSAL METHODS

Electricity Council Research Centre,
Caponhurst
F. Barrett
Effluent and Water Treatment Journal, Vol. 11, No. 4, p. 207-209, April, 1971. 1 fig.

Descriptors: *Effluents, *Farm wastes, *Suspended solids, *Waste disposal, *Waste treatment
Identifiers: *Electrical disposal methods, *Stabilization pond, *Oxidation ditch, *Electrolytic flotation

The growth of more intensive stock farming has added urgency to the search for efficient, economical and acceptable methods for the disposal of farm effluents. Research has indicated that effluent from a herd of 90-100 cows can be dealt with efficiently and economically by spray aeration in a two section stabilization pond. Pig effluent can be made relatively innocuous by treating it aerobically in an oxidation ditch so that its oxygen demand is materially reduced by biological action. It is a process that avoids odor problems and which requires much less land for the disposal of the residue than would be required for untreated effluent. Electrolytic flotation using hydrogen and oxygen produced by the electrolytic breakdown of a small portion of the water in the effluent to raise the solids to the surface is a suitable low-cost method of overcoming most of the difficulties in the removal of suspended solids from effluent. (Cameron-East Central)

### 2093 - A1, B1, E2 400

### COMPOSTED CHICKEN LITTER SEEMS TO RECLAIM SALT-DAMAGED LAND

Crops and Soils Magazine, Vol. 27, No. 4, p. 24, January 1975

Descriptors: *Salts, *Reclamation, Oil wells, Grasses, Land
Identifiers: *Compost, *Chicken litter, Manure, Application rates

Research was conducted by the University of Arkansas using composted chicken litter to reclaim land that was damaged when salt water from oil wells overflowed onto it. Composted chicken manure was applied at a rate of 6 tons per acre and rototilled into the salt-damaged soil to a depth of about 4 inches. The plot was then seeded to a combination of grasses including switchgrass, millet, bahia, bermudagrass, and lespedeza. Soil tests taken before and after the compost application indicated that the treatment was effective in reclaiming the salt-covered area. Agronomist L. H. Hileman says this reclamation method will also effectively eliminate the salt problem from other sources of salt (such as saline seeps). More research is needed to determine the proper rates of application and to evaluate different types and kinds of compost. (Cameron-East Central).

### 2094 - A5, D3 400

### NEW ODOR CONTROL PRODUCT NOW AVAILABLE

Calf News, Vol. 12, No, 6, p. 29, June 1974

Descriptors: *Odor, *Control, *Bacteria, Feedlots, Farm wastes
Identifiers: SUBDU, Fy larvae

SUBDU, a dried combination of two bacterial enzyme cultures, B. Subtilis and B. thuringiensis Berliner, is a new odor control product for feedlots available from BZD Livestock Products, Inc., Lincoln, Nebraska. The "manure and waste material digester" can be used to neutralize manure and organic waste odors. The product also aids in controlling fly larvae in manure and litter. According to BZD, it takes about 10 days after initial treatment for the enzyme cultures to work. It may be used to control odors in outdoor lots, confinement buildings and manure lagoons and pits. (Cameron-East Central).

### 2095 - A1, B1 400

### URINARY EXCRETION OF QUINALDINE BY CHANNEL CATFISH

U. S. Fish and Wildlife Service, Fish Control Laboratory, LaCrosse, Wisconsin 54601
J. B. Hunn, and J. L. Allen
The Progressive Fish-Culturist, Vol. 36, No. 3, p. 157-159, July, 1974. 1 fig, 1 tab, 12 ref.

Descriptors: *Urine, *Channel catfish
Identifiers: *Quinaldine, *Excretion, Catheterization, Anesthetic

The study was undertaken to determine the rate of renal elimination of quinaldine following exposure of channel catfish obtained from the National Fish Hatchery, Fairport, Iowa. Following catheterization, the fish were placed in chambers and exposed to 30 mg/1 of the anesthetic for not less than 30 minutes. Quinaldine was excreted in the urine of catfish following exposure to the anesthetic quinaldine sulfate, but the amount eliminated from the fish's body via the gill and/or gut can only be estimated. Urinary excretion of quinaldine was less than 5 percent of the total body residue eliminated during 24 hours of withdrawal in freshwater. (Battles-East Central).

### 2096 - A5, B1, C1, E2, F1 300

### SLATTED-FLOOR SYSTEMS FOR BEEF FINISHING

Tennessee University, Knoxville
J. I. Sewell and J. B. McLaren
Tennessee Farm and Home Science Progress Report 88, Tennessee Agricultural Experiment Station, University of Tennessee, October, November, and December, 1973, 4 p. 4 fig, 2 tab, 6 ref.

Descriptors: *Waste disposal, *Slabs, *Costs, *Odors, Labor, Confinement pens, Cattle
Identifiers: *Floors, *Slatted floor, *Beef production, Facility design, Stocking density, Behavior, Waste accumulation rates

A slatted-floor beef finishing facility was completed at the University of Tennessee Aluminum Company of America (ALCOA) Farm in the fall of 1971. An existing barn was remodeled to provide a means of comparing three floor types — concrete-slab floor, concrete slats and aluminum slats. Data was collected on facility design, costs, stocking density, cattle behavior, odors, manure accumulation rates and manure removal. Labor requirements for manure management on slatted floor and slab floor systems were also compared. After two years of operation the results and observations suggested some advantages for the slatted floor system. The major results and observations were: (1) Liquid waste collected in the pits at 0.73 cubic ft per head per day, (2) Before unloading with a vacuum tank-spreader, agitation of manure in pits was required, (3) Almost no surface runoff was produced by the slat system and (4) Aluminum slats were noticeably cleaner than concrete slats. The concerns associated with the slatted floors are: (1) Higher initial facility costs, (2) Odors for a few days after surface spreading of wastes and (3) The provision of adequate ventilation and air exchange during hot and humid weather, (Kehl-East Central).

### 2097 - B1, D2, E3 100

### SIZE DISTRIBUTION AND NUTRITIONAL VALUE OF SWINE MANURE SEPARATES

Associate Sanitary Engineer, Natural Resources and Environmental Protection Department, Frankfort, Kentucky
S. C. Jett, I. J. Ross, H. E. Hamilton, V. W. Hays
Transactions of the ASAE, Vol. 17, No. 5, p. 965-967, September-October, 1974. 2 fig. 1 tab, 4 ref.

Descriptors: *Nutrients, *Particle size, Separation techniques
Identifiers: *Swine, *Manure separates, Nutrition, Crude protein, Ether extract, Nitrogen-free extract, Ash, Wet screening

The nutrients in manures can be utilized to some extent in animal diets. This study's objective was to determine the extent that a mechanical size separation process can be used to separate the major nutritional components in swine waste. For the manure samples tested, there was remarkable consistency in the distribution of the particle sizes and the four proximate components (crude protein, ether extract (EE), nitrogen-free extract (NFE) and ash) within the size range tested (0.250 mm to 3.36 mm). Considering the manure produced by the swine on all three of the study's rations, more than 83% of the crude protein, 93% of the ether extract and 97% of the ash were contained in manure portions that passed during wet screening through the 0.250 mm screen. The portion of the manure that did not go through the 0.250 mm screen contained more than 60%

of the NFE. Therefore, wet screening can be used for the effective separation of NFE from the other proximate components. If it were desirable to concentrate either the crude protein of the NFE portions of the manure, this separation would be useful for formulation of rations containing swine manure. (Kehl-East Central).

2098 - A1, B1 400

### TREAT YOUR WASTE RIGHT

G. Warren
Soil Conservation, Vol. 38, No. 6, p. 130-132, January, 1973. 3 fig.

Descriptors: *Waste treatment, *Waste disposal, *Sewage, *Louisiana, *Lagoons, *Streams, *Water pollution
Identifiers: *Animal wastes, *Soil Conservation Service

Rural Louisiana is freeing its streams and countryside from sewage, garbage, and animal wastes. The Soil Conservation Service in cooperation with the Louisiana State Board of Health provides technical help in designing and constructing sewage lagoons and animal-waste systems. The SCS is called on for soil maps and interpretations to help locate sites for both types of systems. A sewage lagoon system at Coushatta not only costs about one-tenth of what a treatment plant costs but it also keeps the sewage from going into the Red River. More than 150 animal-waste systems have been built in the state by dairymen. This type of waste no longer goes into the streams; it goes into the lagoon. (Cameron-East Central).

2099 - D3 300

### AMMONIA REMOVAL FROM AGRICULTURAL RUNOFF AND SECONDARY EFFLUENTS BY SELECTED ION EXCHANGE

Battelle Memorial Institute, Pacific Northwest Laboratories
Robert A. Taft Research Center Report No. TWRC-5, March, 1969, 58 p. 19 fig. 7 tab, 33 ref.

Descriptors: *Agricultural runoff, *Effluents, *Ion exchange, *Waste water, Nitrogen, Lime
Identifiers: *Ammonia removal

A selective ion exchange process was developed for the removal of ammonia nitrogen from wastewaters. The process employs a natural zeolite, clinoptilolite, which is selective for ammonium ions in the presence of sodium, magnesium, and calcium ions. The ion exchange equilibria of four zeolites was investigated and clinoptilolite was selected for further study on the basis of its ammonium ion selectively and low cost. A mobile demonstration plant having a capacity of 100,000 gallons per day was designed and constructed to remove ammonia from wastewater. The plant contains facilities for flocculation, sedimentation, powdered activated carbon absorption, disinfection, and mixed media filtration followed by ion exchange and associated regeneration equipment. Operations of the mobile plant with secondary effluent resulted in ammonia removals of 97 and 93 percent at 70,000 and 100,000 gallons per day respectively; thus demonstrating that selective ion exchange provides a highly effective means for removing ammonia from wastewater. (Cameron-East Central).

2100 - A1, D4, E3 300

### FACTS ON METHANE PRODUCTION FROM ANIMAL WASTE

Department of Agricultural Engineering, College of Agriculture and Life Sciences, Wisconsin University, Madison
J. C. Converse and R. E. Graves
Bulletin No. A2636. College of Agricultural and Life Sciences, University of Wisconsin, Extension, Madison, July 1974, 4 p.

Descriptors: *Methane, *Recycling, *Energy, *Organic matter, Anaerobic conditions, Nitrogen, Phosphorus, Potassium, Pollutants, Effluent
Identifiers: *Manure, *Bio-gas

This fact sheet outlines information concerning methane production from animal waste. It is possible to produce heating gas from animal manure on crop residues in the form of methane. Constant conditions of temperature, fresh organic matter, pH of 7.0 to 7.6, and anaerobic conditions promote methane production. The equipment required to produce methane is a simple batch-loaded digestor/fed a mixture of organic matter and water. Maximum volume reduction of the infed materials will be 5 percent. The output will not increase the amount of nitrogen, phosphorus, or potassium but it will likely be in a more available form. Pollutants will not be significantly reduced. Manure from a 1400 pound cow would produce about 60 cu. ft. of gas at atmospheric pressure per day. The bio-gas usually contains about 70 percent methane, 30 percent $CO_2$, and a small amount of $H_2S$ and other gases. Not all of the bio-gas energy is available for utilization and no exact figure can be given to how much less the net energy is than the gross energy. The methane gas can be burned in tractors and cars, used for cooking, heating water and buildings, air conditioning, grain drying or operating stationary machines. A typical grain dryer (four million Btu/hr.) would require 3330 cu. ft. of bio-gas compressed to 300 psi for a 10-hour day. Although methane in a concentration of 6 to 15 percent with air is an explosive mixture, research in progress may make this process usable by individual farmers. (Batties-East Central).

2101 - A1, B1 200

### EFFECTS OF MANURE GASES AND AERIAL DUST ON PIGS

S. E. Curtis, C. D. Anderson, J. G. Drummond, D. W. Kelley, D. A. Kingdon, et. al.
Proceedings, Illinois Pork Industry Day, Illinois University, Animal Science Department AS-665g, Urbana-Champaign, December 4-11, 1973, p. 24-25. 1 tab.

Descriptors: *Gases, *Dust, *Air pollution, Ammonia, Hydrogen sulfide
Identifiers: *Swine, Respiration, Respiratory-tract, Exposure chambers, Absolute humidity, Swine-finishing houses

The effects of ammonia, hydrogen sulfide, and hog-house dust alone and in various combinations in the air on the performance and respiratory-tract health of healthy growing and finishing pigs were studied in seven trials. The performance trials were conducted in four dynamic-type, air pollutant exposure chambers at 65 degrees F. with absolute humidity the same as or lower than the outside air. The air supply to each chamber was filtered and then pollutants were added to the air as it entered the chamber. No pollutants were added to the control chambers. Ammonia, hydrogen sulfide, and hog-house dust at levels as high as or higher than those normally encountered in enclosed swine-finishing houses had little effect on growth performance of the pigs under these experimental conditions. All pigs were sacrificed for complete post mortem examination at the end of the trial. Forty-eight littermate pairs of crossbred pigs one to two weeks old were exposed for 10 minutes to air containing aerosolized escherichia coli of a nonpathogenic strain and to ammonia held at 50 p.p.m. The young pigs' ability to clean nonpathogenic escherichia coli bacteria from their lungs was impaired by exposure to ammonia at 60 p.p.m. during the clearance period. Results suggest that the performance of healthy pigs may not be affected by air pollution inside enclosed swine houses, but that the incidence and severity of lung disease in pigs may be related to the stress caused by such irritating air pollutants as ammonia. (Batties-East Central).

2102 - A1, E2, F1 400

### FEEDLOT MANURE: SUDDENLY IT'S WORTH MORE

Assistant Farm Management Editor, Successful Farming
B. Gergen
Successful Farming, Vol. 72, No. 10, p. 24-25, September, 1974. 1 fig. 2 tab.

Descriptors: *Fertilizers, *Nitrogen, *Phosphorus, *Potassium, *Economics
Identifiers: *Manure, *Application rates, *Land disposal, Micronutrients

Manure is worth more than it ever has been due to the monetary value of the nutrients nitrogen, phosphorus, and potassium as well as micronutrients. It is figured that each cow provides 98 lbs. of N per year making it worth $26-$28 in manure nutrients. If 250 lbs. per acre of nitrogen is added to the soil as manure, about 110 lbs. will be available the first season, 50 lbs. the second season and 25 lbs. the third season. Stockpiled manure is more valuable than freshly scraped manure because (1) it undergoes partial composting, (2) it is drier and more granular and can therefore be spread more uniformly and (3) it has a higher nitrogen content per ton. In general, liquid manure systems retain the most nutrients and in a Wisconsin study, liquid manure knifed between rows of crops resulted in up to 5 percent higher yields than did liquid manure plowed under. Most feedlot manure is being sold to contract haulers for about 50 cents to $1 per ton. Ten to 30 tons of manure per acre can be put on soil every year with beneficial effects on crop yields. Manure application should be accurately matched to soil fertility requirements. Laboratory analysis of the manure may be done by commercial soil fertility labs and by many feed product distributors. Tables are given which may be used to estimate application rates when analysis is not available. (Batties-East Central).

2103 - B1, D1, F1 400

### SLAB VS. SLAT: AN EXPERT'S OPINION

Calf News, Vol. 11, No. 1, p. 14, July, 1973. 1 fig.

Descriptors: *Confinement pens, *Waste disposal, *Design, *Arizona, Costs, Performance, Feasibility studies, Cattle
Identifiers: *Slab-flume design, *Slotted floor design

Presently two types of cattle confinement designs are being promoted, the slat and the slab. The standard design (the slat) is a slotted floor with a scraper in a pit two feet below the slats. A slab is a concrete floor on a one inch in one foot incline with a two inch opening at the lower sides. The manure is moved downward by the cattle's hoofs and is periodically flushed down a flume. Dick Bunger, president of Corral Industries, Phoenix, is an expert on cattle confinement designs and notes the slab design as $18 to $20 cheaper to build than the slot. Mr. Bunger admits that the slab design may not be as effective because: (1) it will not efficiently handle as many cattle per square feet as the slot (50 percent of space is lost because cattle will lie only in certain positions on a slanting slab), (2) the animals are under more stress (cattle skid on slabs), (3) lightweight cattle probably don't have enough hoof weight and friction to move the manure down the slope. (But this has not been proven yet), and (4) if the flume flushing is neglected or the pump breaks down, flooding will occur. Mr. Bunger cautions cattlemen because slab design of cattle confinement has yet to prove economically feasible. A slab-design building is presently being built to prove Mr. Bunger's beliefr. (Kehl-East Central).

2104 - A1, B1, E2 300

### LAND DISPOSAL OF LIVESTOCK WASTE

Cooperative Extension Service
Maryland University,
College Park
H. L. Brodie, and J. T. Kennedy
Agricultural Engineering Release No. 54, Environmental Series No. 5, Cooperative Extension Service, University of Maryland, College Park, 1972, 3 p. 2 ref.

Descriptors: *Water pollution, *Livestock, Lagoons, Erosion, Agriculture runoff
Identifiers: *Land disposal

The production and waste management practices used by farmers determine the extent of water pollution caused by their animal production units. Land spreading of animal wastes is a very effective method of preventing water pollution because of the natural treatment process in the soil. Several means of applying the principle of intercepting and controlling surface and subsurface waters are listed. Watersheds are affected a great deal more by natural pollutants than by animal wastes which are properly spread on land where erosion is controlled. Crop rotation, strip cropping, pasture improvement and the growing of crops for protective cover are the most common erosion control procedures. A list of steps to take in the prevention of pollution from land disposal of livestock wastes is given. Alternate methods of land application during the fall are provided. The best way to judge application rate is from experience by considering slope, slope length, soil type and ground cover. Two obstacles to winter spreading are frozen soil and deep snow. During the winter if a good spreading schedule cannot be followed, the manure should be stored under cover. Additional information on managing lagoons to capture runoff and minimize overflow is provided. If animal production units are properly located and managed, groundwater problems are minimized. (Kehl-East Central.)

2105 - A1, B2, E1 300

### LAGOONS FOR ANIMAL WASTE DISPOSAL

Cooperative Extension Service
Auburn University
Auburn, Alabama
H. Watson
Cooperative Extension Service Circular R-6, Auburn University, July, 1972, 12 p. 6 tab, 3 ref.

Descriptors: *Waste disposal, *Lagoons, *Design, *Management, *Biochemical oxygen demand, Poultry, Livestock.
Identifiers: Water volumes, Sludge removal, Lagoon overflow, Loading.

For several years lagoons have been used for the disposal of livestock and poultry manure with varying degrees of success. A lagoon's effectiveness is determined by its design, construction and management. The two major advantages of lagoons are: (1) the labor requirements are less than for systems where manure is spread onto fields and (2) lagoons usually can be constructed at a low initial cost. There are three major disadvantages of lagoons. (1) Objectionable odors are sometimes present, (2) Improper construction can present a possible source of ground and surface water pollution, and (3) Periodic sludge removal is required. The processes of three lagoon types, aerobic, anaerobic and mechanically aerated lagoons, are discussed. The location, size and construction are examined as important factors in lagoon design. Tables for BOD production and surface area requirements, water volumes for various aerator sizes and for water volume of various anaerobic lagoons are given. The operation and management of a lagoon are explained through the various loading methods, sludge removal and lagoon overflow. Some general management practices that should be followed are given. (Kehl-East Central)

2106 - A5, B-, C1, D1 600

### EVALUATION OF METHODS FOR THE ANALYSIS OF PHYSICAL, CHEMICAL AND BIOCHEMICAL PROPERTIES OF POULTRY WASTEWATERS

Department of Agricultural Engineering
Cornell University
Ithaca, New York
T. B. S. Prakasam, E. G. Srinath, P. Y. Yang, and R. C. Loehr.
Presented at Special Meeting, American Society of Agricultural Engineers Committee SE-413, Chicago, Illinois, December 12, 1972, 71 p. 9 fig. 16 tab, 15 ref.

Descriptors: *Research and development, *Analytical techniques, *Poultry, *Physical properties, *Chemical properties, *Waste treatment.
Identifiers: *Wastewaters, *Biochemical properties, Nitrogen control, Odor control.

Research and demonstration studies were conducted on the treatment of poultry wastes for the past four years with particular emphasis on nitrogen control, waste treatment, and odor control. This research involved the analysis of raw and treated wastewater. Analytical methods were evaluated for their applicability to the routine analysis of animal and especially poultry wastewaters. Objectives of this research were to discuss the results of these investigations and to indicate satisfactory methods for the analysis of physical, chemical, and biochemical properties of poultry wastewaters. Samples of excreta voided from chickens housed at the Poultry Research Farm, Cornell University were used. The various methods used for the analysis of raw and treated poultry wastewater are described. (Cameron-East Central)

2107 - B1, D2, D4, E2, E3 400

### FEEDLOT RECLAMATION "CLOSED SYSTEM"—WASTE RECOVERING: INSULATED

C. Gross
Calf News, Vol. 13, No. 2, p. 36-37, February, 1975. 4 fig.

Descriptors: *Design, *Construction, *Feedlots, *Farm wastes, Bacteria, Confinement pens, Recycling, Heat.
Identifiers: *Closed systems, *Recovery process, Composting, Refeeding.

Jim Jarnagin, with financing from the Kansas Farm Life Insurance Co., built a by-product recovery confinement system, examples of which had already been built by Corral Industries. Running down the structure's 1,140-foot length is a 16 foot-wide alley flanked on the north and south by a row of pens. At a stocking rate of 5,040 head, each animal has 20 square feet of space. The design and construction of the structure are given. After separation of liquids and solids, the processed solid waste is augered to a compost pile, where it remains for two days. After 24 hours, heat pasteurized the compost reducing the pathogens and yielding a product named CI 13. Since the bacterial kill in the recovery process is substantial, the material can be immediately blended back into the ration, or it can be composted until needed. The liquid fraction from the separation process is pumped into a pond. From here it goes out to the fields through a gated pipe sprinkler irrigation system. (Cameron-East Central.)

2108 - A4, B2, D4, E2 100

### NUTRIENT TRANSFORMATIONS IN A SWINE WASTE OXIDATION DITCH

Department of Civil Engineering
Institute of Environmental Sciences and Engineering
Toronto University, Ontario, Canada.
P. H. Jones and N. K. Patni.
Journal Water Pollution Control Federation, Vol. 46, No. 2, p. 366-379, February, 1974. 16 fig, 4 tab, 20 ref.

Descriptors: *Waste treatment, *Phosphorus, *Nitrogen, Design, Swine.
Identifiers: *Oxidation ditch, Land disposal.

Livestock production in confined areas is rapidly gaining popularity in North America as well as in Europe. Of the various possible systems for the treatment and handling of high-strength animal wastes, oxidation ditches are especially attractive because of their simplicity and economy. Jones, Patni and others have established the efficiency of oxidation ditches in reducing oxygen demanding carbon. This seven month study examines the behavior of nitrogen and phosphorus in such units. Nitrogen loss from the ditch was inhibited after about 20 weeks of operation as indicated by nitrogen accumulation in the ditch mixed liquor (DML). It seems that the nitrification-denitrification scheme was distributed by the introduction of wood shavings in the DML beginning about this time. It is concluded that, with proper design and operation, oxidation ditches can be used to effect a high degree of nitrogen removal from high-strength animal wastes. The study also indicated that controlled and regulated land application of the animal wastes treated in oxidation ditches (containing the accumulated phosphorus) seems at present to be the most practical way of preventing phosphates from reaching groundwater at animal waste treatment facilities. (Kehl-East Central.)

2109 - A1 100

### CHARACTERISTICS AND COMPARATIVE MAGNITUDE OF NON-POINT SOURCES

Cornell University
R. C. Loehr
Journal Water Pollution Control Federation, Vol. 46, No. 8, p. 1849-1872, August, 1974. 2 fig, 17 tab, 59 ref.

Descriptors: *Precipitation (atmospheric), Phosphorus, Nitrogen, Ecology.
Identifiers: *Non-point sources, *Runoff, *Pollution, Irrigation return flows, Seepage, Cropland tile drainage.

Definite comparisons of non-point sources are difficult since such comparisons are the result of complex interactions in and on the soil. Identification of non-point sources was based on the reported range of their characteristics and the available technology for their control. They were identified as (1) those not needing control or uncontrollable, (2) those possibly needing control, and (3) those requiring control. The first category included precipitation, unmanaged forest land runoff, and range land runoff. The second one contained crop land runoff, runoff from land receiving manure, crop land tile drainage, and irrigation return flows. The final category included urban land runoff, manure seepage and feedlot runoff. The relative contribution of sources in a watershed will be determined by the human activities that are there. (Kehl-East Central)

2110 - A1 100

### TOXICITY OF SEAWATER TO COLIFORM BACTERIA

Graduate Student
Civil Engineering Department
Washington University
Seattle
H. P. Savage and N. B. Hanes
Journal Water Pollution Control Federation, Vol. 43, No. 5, p. 854-861, May 1971, 16 fig, 1 tab, 16 ref.

Descriptors: *Toxicity, *Seawater, *Coliforms, *Bacteria, *Nutrients, *Biochemical oxygen demand.

This study was undertaken to examine the effect of nutrient levels as measured by BOD analysis, on the toxicity of seawater to total coliforms and fecal coliforms. Three separate experiments were performed. Flasks labeled "condition A" received no additional nutrients resulting in a BOD of between .6 and 1.8 mg/1. Total and fecal coliforms died rapidly in "condition A". "Condition B" consisted of flasks with a moderate concentration of waste water nutrients. The resulting BOD levels ranged from 9.9 to 20 mg/1. Initially, fecal and total coliforms generally increased their share of the total bacterial population and then their proportion declined steadily. The flasks of "condition C" contained a high concentration of waste-water nutrients. The resulting BOD levels were between 101 and 120 mg/1. Again, bacterial populations increased, and then their proportions declined rapidly. (Cartmell-East Central)

2111 - A1, B1, D1 100

### AGRICULTURAL RESEARCH CONCENTRATES ON FARM WASTE

New Scientist, Vol. 59, No. 856, p. 198, July 26, 1973.

Descriptors: *Farm wastes, *Effluent, *Slurries, *Waste treatment, *Regulation, *Great Britain, Economics, Reclamation.
Identifiers: *Research, Water pollution.

Scientists in Great Britain are using straw, hessian sacking, and even hedge-clippings, all of which are freely available in large quantities on most farms, in an effort to cut the cost of farm effluent charges. The aim has been to concentrate on the most extreme of farm slurry problems. Effluent from animals is one of the biggest problems farmers have to face. There is legislation to clamp down on farmers' methods of disposal if pollution of the water or the air infringes the regulations, but with few inspectors to check on what is happening in rivers and streams the law is often broken. In Silsoe they treat slurry by mechanical separation of the solids content from liquid for easier handling and aerobic treatment of the liquid to kill the smell. The process and costs involved are discussed in detail. (Solid Waste Information Retrieval System).

2112 - B1, D2, E3 100

### SHORT CUTS FROM MUCK TO MEALS

New Scientist, Vol. 56, No. 821, p. 456, November 23, 1972.

Descriptors: *Feeds, *Reclamation, Effluent, Fish, Algae, Mollusks, Economics.
Idenitfiers: *Refeeding, *Great Britain.

This article outlines ways of using farm waste as feedstuff. One way is to push farm effluent into a pond to produce plankton which in turn supports fish, which are then harvested. Another possibility is to use not fish but bivalve mollusk, whose entire anatomy and physiology is designed to filter out nutritious particles. The nutritionally valuable algae could also be raised on effluent. The algae would also be useful as generators of oxygen. Beef cattle are already being fed on pellets of chicken dung. This not only disposes of unpleasant wastes, but also saves the farmer feed costs. (Solid Waste Information Retrieval System).

2113 - A1, B1, E2 100

### EFFECTS OF APPLICATION RATE IN DIRECT LAND DISPOSAL OF ANIMAL WASTES

Department of Agronomy, Kansas State University, Manhattan 66506.
L. S. Murphy, G. W. Wallingford, and W. L. Powers.
Journal of Dairy Science, Vol. 56, No. 10, p. 1367-1374. October, 1973. 8 fig. 4 tab.

Descriptors, *Effects, *Solid wastes, *Liquid wastes, Feedlots, Dairy industry, Soils, Chemical properties, Nitrates, Salinity, Phosphorus.
Identifiers: Application rates, Land disposal, Colloidal dispersion, Pollution.

Land disposal of animal wastes is a viable solution to the water pollution problem, but this disposal must be done with care so that new pollution problems don't arise. Excess application of manure can cause excess salinity, nitrates, and/or phosphorus as well as colloidal dispersion. A literature review is given to show the beneficial and detrimental value of manure applications on crops and on soil chemical properties. It was concluded that disposal of both solid and liquid wastes should be accompanied by regular soil analysis to detect accumulation of waste components or reaction products which may be detrimental to both the soil and to underlying aquifiers. (Battles-East Central).

2114 - A2, B2, E1 400

### CONTROLLING MANURE RUNOFF

Pennsylvania State University
A. R. Grout
Feedlot Management, Vol. 16, No. 6, p. 34 35, 38, June 1974. 1 fig.

Descriptors: *Agricultural runoff, *Feedlots, *Slurries, *Liquid wastes, Lagoons, Basins, Methane Costs, Odor.
Identifiers: *Runoff control, Oxidation ditch, Evaporation pond, Composting, Dewatering.

There are several ways in which feedlot runoff may be controlled. Slurry manure can be stored in an open basin. Because this material will not stack, the walls must be high enough and strong enough to hold the semi-liquid manure inside. Solid manure from a bedded barn of partially dried manure from a feedlot can be stored with a stacker unit in a basin. In liquid manure systems slotted floors or concrete slabs can be used for removal of manure, and problems due to cold weather. Agricultural runoff can be reduced by roofing, diversion channels, and efficient evestrough systems. Detention ponds for runoff should be built according to state guidelines. Lagoons or stabilization ponds can cause a partial break down of manure nutrients in water. In oxidation ditches liquid manure is circulated and aerated in a racetrack shaped basin by a paddle wheel or propeller. Evaporation ponds reduce the amount of water for disposal, but are limited to areas of low humidity and rainfall. Composting and dewatering of solids is being practiced in some areas. Production of methane gas from animal manure by anaerobic digestion is another disposal alternative. (Cartmell-East Central)

2115 - C5, D2, D4, E3 400

### ENZYMES DIGEST FIBER IN RECYCLED MANURE

Poultry Digest, Vol. 32, No. 377, p. 318, July, 1973.

Descriptors: *Recycling, *Poultry, Enzymes, Heat.
Identifiers: *Refeeding, *Dried poultry manure, *Digestibility.

While processed poultry manure has given satisfactory results when fed to ruminants, refeeding of it to poultry has been questioned due to its fiber build-up and low energy value. However, Dr. Sloneker (USDA) feels that processed poultry manure can be refed as 25% of a poultry ration through 23 cycles. He feels that fermentation of the manure and chemical decomposition caused by drying break down the fiber and make it more digestible. Improvement of these enzymatic and heat accelerated changes point the way to total recycling with minimum pollution. (Battles-East Central)

2116 - D2, E3, F2 400

### FEED PRICES, ENVIRONMENTAL LAWS HELP SALES OUTLOOK FOR DRYING EQUIPMENT, DPW

Feedstuffs, Staff Editor
G. Emerson.
Feedstuffs, Vol. 47, No. 4, p. 32, 62, January 27, 1975. 1 fig, 1 tab.

Descriptors: *Equipment, *Drying, *Poultry, *Costs, *Feeds, *Fertilizers, *Legislation.
Identifiers: *Dried poultry waste, *Food and Drug Administration, *Refeeding.

Incentives for mechanically drying poultry manure (DPW) are financial and environmental. Two types of producers are buying dryers — those who are about to be legislated out of business and those who have an immediate need or market for DPW as a feed or fertilizer. The Food and Drug Administration has not yet approved the use of DPW as a feed ingredient, but equipment firms believe that if and when it does, the markets for both equipment and the finished product will grow rapidly. There are mare than 25 brands of dryers on the market. Costs of the units range from 13,000 to 200,000. The number of birds needed to justify cost of the system varies, but the most frequent mentioned number is 100,000. The cost of producing a ton of DPW ranges from $45 to $50, depending on moisture content of the manure, fuel cost, and dryer efficiency. The quality of DPW depends upon the diet fed to the poultry, the age of the manure, and the quality of the dryer. Currently, the selling price of DPW ranges from $45 to $120, depending upon the area of the country and whether a demand from nearby feedlots exists. (Battles-East Central)

2117 - A1, B2, E2 300

### FEEDLOT RUNOFF DISPOSAL ON GRASS OR CROPS

Associate Professor, Agricultural Engineering Department, Oklahoma State University.
A. F. Butchbaker.
Prepared by the Regional Extension Project for Feedlot Waste Management, No. 7521, TX: L-1053, 6 p. 3 fig, 4 tab, 2 ref.

Descriptors: *Feedlots, *Agricultural runoff, Irrigation, Costs, Labor, Odor, Salinity, Permeability, Nutrients.
Identifiers: *Land disposal.

The runoff control system begins in the feedlot by providing good drainage and a collection system for conveying the runoff. A settling basin should be used to remove at least 50% of the solids. The liquid should pass through the settling basin and go to a holding pond from which it will be pumped to the field disposal site. The two basic types of liquid disposal are sprinkler and surface distribution. Runoff containing more than 5% solids and up to 15% can be handled by only one system, the manure gun sprinkler. Among the advantages of pumping runoff to the field are: (1) For large amounts of livestock, pumping is economical and labor-saving. (2) Pumping runoff onto crops or grass salvages many nutrients. (3) The runoff can be applied throughout the growing season. Thus, liquid disposal on grass allows nearly year around application of runoff in the southern plains region. (4) The odor problem may be increased, depending upon management. (5) Some salt or other toxic compounds in the runoff, if applied by sprinklers, may deposit on plant leaves, reducing the photosynthesis rate. (6) Tight soils may not have high enough permeability to receive the liquid rapidly. (7) Salinity buildup on the soil is a potential problem. Maximum permissible application rates have not yet been determined. (Battles-East Central)

2118 - A1, B2, F1 300

### FREE STALL HOUSING AND LIQUID MANURE MANAGEMENT FOR THE ENTIRE DAIRY HERD — SYSTEMS APPROACH

Agricultural Engineering Department, College of Agricultural and Life Sciences, University of Wisconsin, Madison.
G. D. Barquest, T. J. Brevik, J. C. Converse, C. O. Cramer, H. J. Larsen, et al.
Progress Report, Project No. 5[illegible]3, College of Agricultural and Life Sciences, University of Wisconsin, Madison, 27 p, 9 fig, 14 tab.

Descriptors: *Dairy industry, *Liquid wastes, *Costs, *Performance, Lagoons, Ventilation, Comparative benefits, Floors.
Identifiers: *Free stall housing, Mastitis, Insulated housing, Uninsulated housing, Slatted floors, Floor scraper.

Three 20 cow free stall barns were compared over a two year period at a Wisconsin University Experimental Farm to determine the effects of three types of free stall housing and two liquid manure systems on cattle health, production, and facility requirements. Barn A was insulated and mechanically ventilated and had slatted floors and an underfloor manure tank. Unlike Barn A, Barn B had solid concrete alley floors with an automatic floor scraper. Barn C was enclosed but uninsulated and had solid floors and a floor scraper. Barns A and B averaged about 40 degrees F. during the coldest weather. The temperature in Barn C fluctuated with the outdoor temperature but ranged 15 to 29 degrees higher. Barn C cattle had a slightly higher incidence of mastitis and a slight reduction in dry matter intake. The cows preferred deep bedded free stalls with dirt bases to rubber mat stalls, carpeted stalls, or concrete stalls; however, the deep bedded stalls required more bedding and labor. For three of the four periods the volume of manure removed from the lagoon was greater than the amount pumped into it due to heavy rainfall and snow accumulation. However, during one relatively dry summer period a reduction in volume of 18 percent occurred. An average of 3.77 cu, ft./cow of milking center wastes, precipitation, manure and bedding was removed from the total system during the two year period. Total solids content of the manure was 7.4 percent for the underfloor tank and 4.8 percent for the storage lagoon. The initial investment and annual costs were about $200 and $20 per cow. Investment and costs were less for the floor scraper—storage lagoon system than for the slotted floor-underfloor tank. (Battles-East Central)

## 2119 - A5, B1, D3 600

### CHEMICAL CONTROL OF MANURE ODOR

Regional Extension Specialist, Feedlot Waste Management, Oklahoma State University.
M. D. Paine.
Unpublished paper, 4 p.

Descriptors: *Odor, Enzymes.
Identifiers: *Chemical odor control, *Manure, *Matching Standards Techniques, *Index of Similarity, Masking agent, Counteractant, Deordorant, Digestive Deodorant.

There are four main types of odor control agents. In the order of decreasing effectiveness these types are: (1) masking agents, (2) counteractants, (3) deodorants, and (4) digestive deodorants. Masking agents are mixtures of aeromatic oils which cover the odor but do not reduce it. Counteractants neutralize the odor with aeromatic oils leaving no overriding odor. A deodorant is a mixture of chemicals that "kill" the odor without the use of another "cover" odor. Digestive deodorants consist of a combination of digestive enzymes, aerobic and anaerobic bacteria that create a digestive process that eliminates the odor. Evaluation of the effectiveness of odor control agents is done by the Matching Standards Technique which requires a testing panel of 8 to 10 people who compare the smell of manure samples and score the control agents from 0 (Most effective) to 8 (least effective). Using this data, a comparison of two agents by an Index of Similarity is possible. Additional information on the Matching Standards technique and on the ratings of odor control products that have been tested can be obtained from Extension Agricultural Engineers in the Great Plains. (Battles-East Central)

## 2120 - A2, B1, F2 400

### THE HIGH COST OF RUNOFF CONTROLS: IS HELP NEEDED?

The Furrow, March, 1975, p. 14-15.

Descriptors: *Costs, *Agricultural runoff, *Control systems, *Feedlots, Livestock.
Identifiers: *Cost sharing, Rural Economic Assistance Program.

New state and federal laws governing runoff control from feedlots will be costly for all livestock producers and may force the smaller ones out of business. Michigan State University economists estimate that runoff controls would cost from $3.98 to $14.37 per head for feedlots with 1,000 head or more, and they could run higher for smaller operations. USDA economists estimate control costs for northern areas could cost $25 per head for a 150-cow dairy and more for smaller dairies. The USDA approved a cost sharing program (REAP) in 1973 which enabled a producer to receive up to 80 percent of the total cost for runoff controls with a maximum of $2.500. The $2.500 ceiling on funds provides little relief for the impact of control costs of large feedlot operations; however, large operations can pass these costs on to consumers more easily than smaller operations. Cost sharing programs for 1975 are questionable because there were no cost-sharing programs in 1974. (Battles-East Central)

## 2121 - A1, E2 100

### EFFECT OF SOIL APPLICATION OF DAIRY MANURE ON GERMINATION AND EMERGENCE OF SOME SELECTED CROPS

Department of Crop and Soil Sciences
Michigan State University
East Lansing
D, C. Adriano, A. C. Chang, P. R. Pratt, and R. Sharpless.
Journal of Environmental Quality, Vol. 2, No. 3, p. 396-399, July/September, 1973. 1 fig., 3 tab, 13 ref.

Descriptors: *Dairy industry, *Feedlots, *Waste disposal, *Germination, *Crop response, *Plant growth.
Identifiers: *Land disposal, *Application rates, Salt injury, Toxicity.

Application to irrigated fields is the most common method of dairy and beef manure disposal in southern California. Considerable concern has developed recently as to the possible environmental problems that could arise from application on fields of large amounts of these manures, especially in areas of concentration of dairies and feedlots. This study's primary objectives were: (1) to evaluate the effect of various dairy manure treatments on the germination of several crops, and (2) to elucidate the possible causes of the germination injury. The crops used in the study were sudangrass (Sorghum sudanese Stapf 'Piper'), barley (Hordeum vugare L. 'Numar'), radish, (Raphanus sativus L. 'Cherry Belle'), and spinach (Spinacea Cleraces L. 'Bloomsdale'). The experiment was carried out in a glasshouse using Chino loam soil and adding various amounts (0, 5, 10, 15, and 20 percent dry manure by weight) of dairy manure. The degree of germination injury was dependent on crop species and application rate of the salt and N. Spinach and radish were more sensitive to salt or $NH_3$ than barley and sudangrass. Barley germination data from various treatments suggest that the germination injury was not salt specific. The study concluded that by planting several days after soil application of large amounts of dairy or feedlot manure or after adequate preirrigation, or both, germination injury can be minimized. (Kehl-East Central)

## 2122 - B1 600

### CONFINEMENT HOUSING SYSTEMS FOR SOWS

Department of Agricultural Engineering
Illinois University
Urbana-Champaign
A. J. Muehling and G. R. Carlisle.
Presented at 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-15, 1972, Paper No. 72-920, 14 p. 6 fig. 6 ref.

Descriptors: *Confinement pens, *Breeding, *Waste disposal, Farm management.
Identifiers: *Sows, Swine, Feeding.,

The number of pork producers has declined while the size of swine production enterprises has grown. This has resulted in economic forces dictating a move toward confinement on many farms. Recently, considerable interest has also been given to confining the breeding herd. An examination of the advantages and disadvantages of sow confinement is given. One advantage is that it made possible better environmental control and more precise waste management. Mud and dust problems are almost completely eliminated in a confinement system. Extremely high environment temperatures greatly affect a pregnant sow at the beginning and end of the gestation period, A well-designed and well-managed system will modify these effects. Sow confinement also gives the producer control over waste disposal. Observations of six confinement systems are given. These systems are: (1) an open-front shed with an outside run, (2) a totally enclosed building with partially slotted floors, (3) an open front, partially slotted-floor building, (4) an all-slotted-floor gestation building, (5) a totally enclosed, partially slotted-floor building with a separate breeding area, and (5) a totally slotted-floor building with individual stalls. Design decisions connected with these systems and costs are given. It was concluded that each producer would have to decide which system or combination of systems would best suit his needs. (Kehl-East Central)

## 2123 - A1, E3 400

### DPM FOR RUMINANTS GROWS IN ENGLAND

Poultry Digest, Vol. 32, No. 377, p. 318, July, 1973.

Descriptors: *Proteins, *Costs, Feeds.
Identifiers: *Dried poultry manure, *England, *Refeeding, Bacterial contamination.

According to Poultry World, February 15, 1973, the use of dried poultry manure (DPM) in rations for ruminants is increasing in England. Research at several of the experimental farms of the British Ministry of Agriculture has shown that not only is DPM an effective protein source in both dairy and beef rations, but it has resulted in feed cost savings. Poultry World has stated that provided the residue is dried at high temperatures, there appears to be no danger from harmful bacterial contamination. Residue tests have shown only minute traces which do not present a hazard. However, in the United States, the Food and Drug Administration has not yet approved the use of dried poultry manure in feeds. (Kehl-East Central)

## 2124 - A2, E2 600

### DESIGN AND OPERATION OF A FEEDLOT RUNOFF DISPOSAL SYSTEM—A CASE STUDY

Agricultural Research Service
U.S, Department of Agriculture
Nebraska University
Lincoln
J. A. Nienaber, C. B. Gilbertson, T. M. McCalla, and F. M. Kestner.
Presented at 1973 Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-432, 16 p. 1 fig. 6 tab, 11 ref.

Descriptors: *Design, *Feedlots, *Agricultural runoff, *Waste disposal, Nutrients, Crop production, Cattle.
Identifiers: *Runoff control.

Several methods have been devised for the control of runoff from outdoor beef cattle feedlots. A runoff-control facility has three major components including a solids settling area, a temporary liquid storage area and a disposal area. The objective of this study initiated in 1970 is to determine the minimum area required to dispose of runoff as affected by applied nutrient and water and disposal area runoff control requirements. The research was conducted on a cooperator site with a 1000-head feedlot and runoff control facility. The study discovered under the conditions tested, that a minimum area of one-half acre disposal per acre of feedlot does not cause a pollutant accumulation in the soil profile or impair crop production. Area required, system components and their operations, and collection of disposal area runoff were included in a final design. (Kehl-East Central)

2125 - A9, B1, E3, F2 400

### CATTLE, POULTRY PRODUCERS PUSH FOR RECYCLING RULES

Feedstuffs Southeastern Correspondent
R. H. Brown
Feedstuffs, Vol. 47, No. 11, p. 9, 67-68, March 17, 1975.

Descriptors: *Cattle, *Poultry, *Animal wastes, *Recycling, Feeds.
Identifiers: *Refeeding.

Cattlemen are searching for cheaper feedstuffs for cattle because of market demands and because of consumer objection to feeding feedstuffs to cattle that can be used directly by man. Recycling of waste materials would help reduce the waste problem and provide some economic relief for the cattlemen. Dr. O. W. Charles of the Georgia Extension Service has completed an environmental impact study on waste materials for presentation to the Food and Drug Administration. The study revealed that there are more than two billion tons of wet waste material which must be disposed of. Semi-optimistic predictions exist as to when the FDA may publish regulations. Charles pointed out that environmentalists will probably file suits against recycling when regulations are issued. Because feeders have already moved ahead of researchers in feeding recycled waste and because states may issue regulations, the FDA may be moving a little faster than in the past to get regulations passed. Currently, negotiations are concerned with the Bureau of Foods. When agreement is reached between this agency and the FDA's Bureau of Veterinary Medicine, the proposed regulations may reach the Federal Register. Vegetable materials from processing plants and hydrolized proteins are other waste materials being studied as probable recyclable wastes. (Battles-East Central).

2126 - A1, B1, C1, D1, E1 100

### AGRICULTURAL WASTES

Mississippi State University, State College.
J. L. Mahloch and E. C. McGriff Jr.
Journal Water Pollution Control Federation, Vol. 46, No. 6, p. 1280-1283, June, 1974. 20 ref.

Descriptors: *Livestock, *Properties, *Waste treatment, *Waste disposal, Bacteria, Nutrients.
Identifiers: *Literature review, *Agricultural wastes, Pyrolysis, Refeeding, Land disposal.

A literature review is given of studies concerning the characterization of livestock waste and its impact, design of treatment systems, use of land disposal, and reuse capabilities. Isolation of bacteria, waste accumulation rates, pyrolysis of wastes, nutrient removal in waste treatment ponds, various waste treatment systems, effect of land applications on crops, and refeeding are just some of the topics considered in this review. The applicability of this current research is affected by current and proposed control regulations and the viability of the agricultural sector of the economy. (Merryman-East Central)

2127 - A1, B2 700

### SEALING OF ANAEROBIC DAIRY WASTE LAGOONS IN SANDY, HIGH WATER TABLE SOILS

Graduate Assistant
Department of Agricultural Engineering
Florida University
Gainesville
C. G. Osterberg
Unpublished MS Thesis, Florida University, Gainesville, 1972, 75 p. 20 fig. 20 tab, 14 ref.

Descriptors: *Soils, *Water, *Florida, *Dairy industry, Waste treatment, Sampling, Analysis, Seepage, Flow rates, Sands, Groundwater, Nutrients.
Identifiers: *Sealing, *Anaerobic lagoons, Loading rates, Hydraulic head, Microbial activity, Manure.

A study was done to investigate the physical and biological sealing mechanism of anaerobic dairy wastewater ponded over highly permeable Florida fine sand. The effects of hydraulic head, manure loading rate and inhibited microbial activity were studied. Graphic analysis showed that the column receiving manure experienced a rapid reduction of flow rate to approximately 45 percent of the initial flow for the low loading rate and to 12 percent of the initial flow for the higher loading rates. After 113 days of manure loading, flow rate returned to 50 percent of the initial value for the low loading rate and to 30 percent for the higher rates. Little effect of hydraulic head on flow rate could be detected in the 15 cm. to 60 cm. range studied. The ultimate degree of soil sealing appears to depend on manure loading rate, although long term testing is needed to determine if the ultimate sealing is related to the rapid sealing trend observed after several days of manure loading. (Cameron-East Central)

2128 - A6, B2, D4 700

### ANAEROBIC DIGESTION OF CHICKEN MANURE

A. C. Anthonisen
M. S. Thesis, Department of Civil Engineering, Clarkson College of Technology, Potsdam, New York, September 24, 1965. 78 p. 18 fig. 11 tab, 36 ref.

Descriptors: *Anaerobic digestion, *Poultry, *Mathematical models, Gases, Chemical properties, Sodium chloride, Sludge.
Identifiers: *Ammonia nitrogen, Loading rates, Detention time.

The purposes of this investigation were to determine the feasibility of treating chicken manure by anaerobic digestion, to determine the effect of a cationic antagonist on such digestion, and to analyze the kinetics of the anaerobic process through use of a mathematical model. The results of this research have indicated that further research is needed before definite conclusions may be drawn. However, anaerobic digestion of chicken manure appears to be feasible under carefully controlled conditions. These conditions include: pH — 7.4, volatile acids—1500—above me/1 as acetic acid, alkalinity—1000—12000 mg/1 as calcium carboniate, ammonia nitrogen—1500 mg/1, detention time—20 days, loading—.088 (lb. V.S./cu. ft. of volume day), temperature—35° C, and Sodium Chloride additions. It was concluded that high ammonia nitrogen concentrations are toxic to anaerobic digestion addition of sodium chloride to a digester with high ammonia nitrogen concentrations appears to increase gas production, and gas from chicken manure digestion is burnable. (Cartmell-East Central)

2129 - E3 400

### DPW SAVES $26.75 PER TON OF LAYER FEED

Poultry Digest, Vol. 32, No. 378, p. 345, August 1973.

Descriptors: *Costs, *Economics, *Feeds, *Poultry.
Identifiers: *Dried poultry waste, *Refeeding.

Layer operators could have saved $26.75 per ton by substituting DPW for corn at a rate of 13 percent of total ration. These figures were based on June 11 feed prices at Atlanta. Dr. O. W. Charles, extension poultry nutritionist, University of Georgia, using a typical layer ration, provided figures to a computer and allowed it to select ingredients which would provide the same nutritional values for the typical ration and the DPW ration. Typical ration cost was $148.30 as compared to $121.55 for the DPW ration, with the DPW ingredient assigned a value of $63.60 per ton. According to Dr. Charles, DPW varies in its chemical composition and biological value because of differences in the methods of handling and processing DPW and in the diet of the hen. "Valuable materials can be processed from DPW," Dr. Charles stated. "If it is properly handled, DPW does have a significant value in a laying hen ration. If it is poorly handled and poorly processed, it has practically no value at all expect for the mineral content." (Kehl-East Central)

2130 - A1, E2 100

### EFFECT OF EFFLUENT FROM BEEF FEEDLOTS ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

Department of Agronomy
Nebraska University
Lincoln
D. G. Hinrichs, A. P. Mazurak, and N. P. Swanson.
Soil Science Society of America Proceedings, Vol. 38, No. 4, p. 661-663, July-August, 1974. 5 tab, 11 ref.

Descriptors: *Feedlots, *Cattle, *Effluent, *Soils, *Physical properties, *Chemical properties, Nebraska.

As feeding operations have increased, the problems of waste management, disposal and utilization have multiplied. The disposal of solid and liquid wastes has become an important pollution problem with the increase in feedlot size. This field study's main objective was to determine the effects of effluent applications on soil physical properties. Beef feedlot effluent was applied as irrigation over a 2-year period to a Colo silty clay loam soil in Eastern Nebraska. Atlas sorghum (Sorghum bicolor L. (Moench)) was used as the crop in 1971 and 1972. The weekly irrigation applied during the growing season ranged from 0- to 5.0 cm. of water or effluent. No statistically significant difference in soil bulk density, water-retention charactersitics, or size distribution of particles and water-stable aggregates was produced by effluent applications. However, significant differences were measured in the hydraulic conductivities of disturbed soil samples. Also soil permeability was reduced. An increase in the electrical conductivities and Na+, K+ and C— in the leachates obtained from hydraulic conductivity determinations for the effluent-treated plots was noted during the growing season. Leaching from winter rains, however, essentially eliminated these increases except for K+ which was greatly reduced. (Kehl-East Central)

2131 - A1, E2 100

### THE EFFECT OF LARGE APPLICATIONS OF MANURE ON MOVEMENT OF NITRATE AND CARBON IN AN IRRIGATED DESERT SOIL

Imperial Valley Conservation Research Center
Brawley, California
B. D. Meek, A. J. MacKenzie, T. J. Donovan, and W. F. Spencer.
Journal of Environmental Quality, Vol. 3, No. 3, p. 253-258, July-September 1974. 9 fig. 3 tab, 8 ref.

Descriptors: *Nitrates, *Carbon, *Movement, Leaching, Irrigation.
Identifiers: *Land disposal, *Application rates, *Desert soil, Crop growth.

The large number of cattle concentrated in feedyards has caused manure disposal to become a serious problem. Application of manure at high rates on agricultural land is a practical solution and is the most inexpensive disposal means. This study's objective was the evaluation of the movement of Mn, nitrate and soluable organic carbon after application of varying manure rates and irrigation schedules. The amount of soluble organic carbon in the soil solution was greatly increased by manure application. Along with restricted oxygen movement from the atmosphere, the organic carbon energy source moved to the 80-cm. depth causing reducing conditions, solution of manganese, and reduction of nitrate. When manure was applied only 1 year, leaching of nitrate occurred to a depth of 80-cm during the next year because of less extreme reducing conditions. These results indicate that it should be possible to adjust irrigation schedules and manure application rates for fine-textured soils in desert regions so that very little nitrate would be leached below the root zone. To do this and achieve good crop growth, adjustment of the two factors would be necessary so that the surface soil is aerobic while a reducing zone is present in the subsoil. (Kehl-East Central)

2132 - A1, B1, C1, D1, E1, F1, F2
500

### AGRICULTURAL WASTE MANAGEMENT: PROBLEMS, PROCESSES AND APPROACHES

**Department of Agricultural Engineering**
**Cornell University**
**Ithaca, New York**
**R. C. Loehr**
**New York Academic Press, 1974, 576 p. 121 fig, 101 tab, 667 ref.**

**Descriptors: *Waste disposal, Legal aspects, Agricultural runoff, Lagoons, Ponds, Aerobic treatment, Anaerobic conditions, Economics, Water pollution, Air pollution, Livestock, Dusts, Gases, Bacteria, Drying, Methane, Sewage, Fertilizers, Nitrogen.**
**Identifiers: *Agricultural wastes, *Waste management, Land disposal, Processing, Biological processes, Composting, Animal wastes, Food processing wastes.**

This book underscores the magnitude of the agricultural waste problem and points out the alternative methods of handling and treating agricultural wastes. Methods integrating engineering and scientific fundamentals are applied to the development of sound agricultural waste management systems. Aspects of the problem discussed are: (1) the legal and social constraints of pollution control, (2) changing practices in agriculture, (3) environmental impact of all wastes related to agriculture and the characteristics of their wastes. Fundamentals and processes discussed are (1) biological processes, (2) ponds and lagoons, (3) aerobic treatment, (4) anaerobic treatment, (5) utilization of agricultural wastes, (6) land disposal of wastes, (7) nitrogen control and (8) physical and chemical treatments. Management approaches to help establish a balance between agricultural production, profit, and environmental quality are also discussed. (Battles-East Central)

2133 - A1, E2 300

### ANIMAL WASTE UTILIZATION FOR POLLUTION ABATEMENT — TECHNOLOGY AND ECONOMICS, PHASE I

**Agricultural Engineering Department, Nebraska University, Lincoln.**
**O. E. Cross**
**OWRR Project Completion Report, Nebraska Water Resources Research Institute, Lincoln, June, 1971, 34 p. 7 fig. 13 tab, 2 ref.**

**Descriptors: *Water pollution, *Sources, *Farm wastes, *Pollution abatement, *Irrigation water, Water utilization, Crop response, Soils, Waste disposal, Sodium, Potassium, Electrical conductance, Waste disposal, Nitrates.**

The pollutional potential of the surface runoff water was based upon the following factors: nitrate nitrogen, sodium, potassium, and electrical conductance. Based upon these four factors, this study indicates that high manure applications to cultivated soils will cause pollution of surface runoff water only during the first fifteen minutes of the first runoff event. Although "polluted," the concentration of pollutants in this runoff water is below the limits set for irrigation water. Hence, all runoff should be recycled for irrigation uses only. After one year of heavy manure application, the underground water (static level at 47 feet below grade) retains potable quality. Indications are that repeated annual application of heavy rates of manure on land will lead to deterioration of the physical properties of soil, owing to the large amounts of sodium and potassium in manure. Also, feeding large quantities of sodium and potassium beyond the minimum requirement for the animals should be avoided. Irrigation techniques indicate: (1) the initial intake of water into the soil increases as higher manure loadings are applied, (2) the basic intake rate is higher on areas plowed 8 inches deep, and (3) the basic intake rate on any specific manure loaded area increases with time elapsed from date of manure application. (Cross-Nebraska University)

2134 - C2, D2 100

### DRYING CHARACTERISTICS OF FORMED POULTRY EXCRETA

**Application Engineer, Canning Machinery Division, FMC Corporation, Hoopeston, Illinois.**
**T. M. Midden, I. J. Ross, H. E. Hamilton, J. J. Begin.**
**Transactions of the ASAE, Vol. 16, No. 2, p. 331-333, March-April, 1973. 5 fig, 2 tab, 4 ref.**

**Descriptors: *Poultry, *Drying, *Physical properties.**
**Identifiers: *Excreta, Crust, Cylinders, Drying techniques.**

Poultry manure as excreted is a high-moisture content semi-solid slurry with no definite geometric shape. There are no void spaces within the mass through which drying air can be forced. Manures could be dried by conventional deep bed drying techniques such as those used to dry small grains if they could be formed into regular shapes and made to retain these shapes in a stack. It is possible to extrude a cylinder of manure, cut it into short lengths, expose it to high temperature drying air to form a crust, and complete the drying in a deep bed drier. Research was performed to deal with (1) the determination of thin layer drying constants as affected by drying air temperature and cylinder diameter and (2) the determination of the hardness of the crust formed around a pellet of manure when exposed to varying drying air temperatures for different periods of time. A discussion is given on the experimental results of this study. (Cameron-East Central)

2135 - A1,B1,C1,D1,E1,F1, F2 100

### AGRICULTURAL WASTE CONFERENCE

**Michigan State University**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, Michigan, May 22-23, 1974, 211 p.**

**Descriptors: *Animal wastes, *Design, *Michigan, *Recycling, Chemical properties, Physical properties, Odor, Economics, Feedlots, Confinement pens, Dairy industry, Permits, Nutrients, Legal aspects,**
**Identifiers: *Waste management, Housing, Land disposal.**

A conference was held at Michigan State University to discuss animal waste management and utilization. The two day program included: (1) a tour of active research projects, demonstrations and facilities focusing on animal and municipal wastes. Brief summaries of the research projects are included in the proceedings; (2) an evening discussion period featuring 5 to 8 minute slide presentations of waste handling systems and equipment by design engineers and company representatives; (3) a full day of papers on topics selected by the conference planning committee. (Cartmell-EastCentral)

2136 - A2, A5, B1, D4, E2 700

### ANIMAL WASTE SYSTEMS

**Extension Agricultural Engineer**
**Michigan State University**
**T. L. Loudon and L. R. Prewitt**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 1-10, 6 fig, 1 tab.**

**Descriptors: *Feedlots, *Confinement pens, *Michigan, Waste storage.**
**Identifiers: *Waste management, *Open lots, Partially covered lots, Stanchion dairy barn, Runoff control, Flushing systems, Slotted floors, Land disposal.**

The components of waste management systems for six types of confinement housing were discussed. The components include collection, storage, and land disposal of manure as well as runoff control systems for outside lots. Collection may be by mechanical scraping or manure may may collect in a pack where deposited or be worked through slotted floors. Storage structure design and manure consistency will determine whether the material must be handled as a liquid or a solid when emptying stored wastes. Land disposal rates should be based on the nutrient content of the waste and this can change during storage, particularly in the case of nitrogen. (Cartmell-East Central)

2137 - A1, B1 700

### PLANNING AND DESIGNING WASTE STORAGE SYSTEMS

**Soil Conservation Service**
**Ann Arbor, Michigan**
**B. E, Boescn and P. W. Koch**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 11-19. 3 fig.**

**Descriptors: *Design, *Waste storage, *Confinement pens, Nutrients, Nitrogen.**

Methods for coordinating storage unit design with livestock operations, cropping systems, and the characteristics of the cropland soils on the farm are presented. Improper storage or management of manure can be a source of serious pollution lakes and streams. It is necessary to design and manage a storage system that will reduce the loss of plant nutrients from the manure, prevent compaction of cropland soils by equipment during wet periods, provide better use of labor through mechanization of manure handling, reduce mud problems around livestock enterprises, and provide for the application of manure when crops can best use the nutrients. There is no single best method for waste collection and storage. Topography soil type, space limitations, economics, location, etc. all influence the method chosen. The entire livestock enterprise must be considered in planning waste management design. The type and design of storage units must recognize the nature of foundation (soil) materials on the site. Provision must be made for management of all water at the site as well as manure. Specific computations are given for various storage systems. (Cartmell-East Central)

2138 - A5, B1, C5 700

### COMPOSITION OF WASTE AS EXCRETED, CHANGES DURING STORAGE, AND ODOR DEVELOPMENT

**Department of Agricultural Engineering**
**Michigan State University**
**J. B. Gerrish**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 21-24, 4 fig, 3 ref.**

**Descriptors: *Chemical properties, *Physical properties, *Waste storage, *Odor, Moisture content, Confinement pens, Ammonia, Nitrogen.**
**Identifiers: *Coprophage.**

It is very difficult to distinguish between manure storage and manure treatment since during storage some kind of biological activity usually takes place. This biological activity changes the form of the manure and its odors. Coprophage is defined as "to eat waste." One of the most important conditions for coprophage is the moisture content on the manure. Odors are more serious for wet storage systems than for dry ones. Some chemical compounds which have been identified in the air from the anaerobic decomposition of livestock and poultry manures are listed. Odorous compounds are also identified for the atmosphere of a beef cattle confinement chamber under three manure handling programs: clean and wash daily, shovel out daily, and no cleaning. The list clearly indicates the advantage of daily cleaning. (Cartmell-East Central)

2139 - A5, B1, D1, E1, F2 200

## ODOR PROBLEMS ASSOCIATED WITH AGRICULTURAL WASTE HANDLING

**Air Pollution Control Division**
**Department of Natural Resources**
**P. R. Shutt**
**Presented at Agricultural Waste Conference Emphasis - Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 25-29.**

**Descriptors: *Odor, *Michigan, *Air pollution, *Regulation, *Permits, Poultry, Cattle, Dairy industry.**
**Identifiers: *Waste handling, Swine.**

**The Air Pollution Control Commission is responsible for controlling air pollution in the state of Michigan, The Michigan Air Pollution Control rules require that a permit be obtained from the Commission prior to installation of facilities which could result in air pollution or prior to the installation of facilities meant to control air pollution. This is interpreted to include agricultural facilities as well as other industries. Michigan's main agricultural odor sources, poultry, swine, beef and dairy operations, have several factors in common—large concentrations of livestock in confined areas, problems with good housekeeping, and/or liquid waste handling systems. Thus isolation, good housekeeping methods, and good waste disposal methods and techniques are desirable. Specific procedures and recommendations are made for each of these four types of livestock operations. (Merryman-East Central).**

2140 - A2, B1, E2, F1, F2 200

## ECONOMIC IMPACT OF SELECTED POLLUTION CONTROL MEASURES ON BEEF AND DAIRY FARMS

**Agricultural Economist**
**Economic Research Service**
**U. S. Department of Agriculture**
**J. B. Johnson**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 31-43, 7 tab.**

**Descriptors: *Water pollution, *Regulation, *Permits, *Costs, Agricultural runoff, Feedlots, Dairy industry, Michigan.**
**Identifiers: *Effluent guidelines, Land disposal.**

**The U. S. Environmental Protection Agency point source effluent guidelines are described in detail as they pertain to beef and dairy operations. Even the smaller dairy and beef feedlots (under 1 000 animal unit capacity) may be expected to comply with effluent guidelines established by water pollution control agencies. Michigan and other states will have state administered, federally approved permit programs for point source dischargers. Feedlots and dairy farms with surface water control problems will receive permits for continued operation contingent on a specified time for taking corrective measures. The application of these effluent guidelines will have differential effects on capital outlay requirements and production costs, depending upon feedlot capacity or dairy herd size and the type of housing in use. (Cartmell-East Central)**

2141 - A1 200

## MICHIGAN'S ENVIRONMENTAL CONTROL PROGRAM AND ORGANIZATION

**Deputy Director, Environmental Protection Branch, Department of Natural Resources, Michigan**
**R. W. Purdy**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 45-50, 1 fig.**

**Descriptors: *Michigan, *Water pollution, *Air pollution, Eutrophication**
**Identifiers: *Environmental control**

**Data on Michigan streams shows that a large majority are not experiencing water quality problems. Approximately 85 stream segments have known or suspected water quality problems from point source discharge. About half of the state's lakes may be experiencing eutrophication, This is a natural aging process which can be accelerated by man's activities. Michigan estimates about one third of its lakes to be over-fertilized from unnatural sources. In general, it was concluded, the water resources of Michigan are in good condition. The air pollution problems in the areas other than highly populated metropolitan centers are basically caused by emmission of air contaminants from industrial operations. The major contaminants for which there is concern are sulfur dioxide and suspended particulate matter. (Cartmell-East Central)**

2142 - A1, B1, F2 200

## NPDES PERMIT SYSTEM AND GUIDELINES FOR MICHIGAN PRESENTED AT THE AGRICULTURAL WASTE CONFERENCE, MICHIGAN STATE UNIVERSITY

**Regional Water Quality Administator, Bureau of Water Management, Michigan Department of Natural Resources**
**T. L. Kamppinen**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 67-69.**

**Descriptors: *Permits, *Water pollution control, *Feedlots, *Confinement pens, Livestock**
**Identifiers: *Discharges**

**October 18, 1972, Congress passed Act 92-500 known as the Federal Water Quality Act Amendments of 1972. This Act was passed over a presidential veto. Section 402 established the National Pollutant Discharge Elimination System Permit Program. The Act required all point source dischargers to obtain a NPDES Permit by not later than December, 1974. The guidelines defined the term feedlot as a confined animal or poultry growing operation where crop or forage growth or production is not sustained in the area of confinement. To be recognized as a feedlot, the feedlot must meet one of the following citeria: (a) 1000 slaughter steers and heifers, (b) 700 dairy cattle, (c) 2500 swine over 55 lbs., (d) 10,000 steers, (e) 55,000 turkeys, (f) 100,000 laying hens or broilers, (g) operations with unlimited continuous flow watering system, or (h) 1000 animal units from a combination of cattle, swine, or sheep. Michigan's requirements for filing of permit applications are discussed. (Cartmell-East Central)**

2143 - A1, F1 200

## POLLUTION ABATEMENT ON FARMSTEADS

**Agricultural Stabilization and Conservation Service**
**R. Locher**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 71**

**Descriptors: *Pollution abatement, *Costs, *Farms, *Government finance**
**Identifiers: *Cost-sharing**

**The Federal Government shares the cost with farmers under the 1974 Rural Environmental Conservation Program and the 1973 Rural Environmental Assistance Program for carrying out pollution abatement practices on farmland. Both conservation programs are available to farmland owners throughout the 1974 year. Requests for cost-sharing must be filed and approved by the local county ASC committee before the practice is stated. (Cartmell-East Central)**

2144 - C5 200

## EFFECT OF HOUSING TYPE ON NUTRIENT COMPOSITION OF BEEF CATTLE MANURE

**Department of Crop and Soil Sciences, Michigan State University**
**D. C. Adriano**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 73-84, 6 tab. 7 ref.**

**Descriptors: *Housing *Nutrients, *Chemical properties, *Nitrogen, *Phosphorus, *Potassium, *Salts, *Feedlots, Climate**
**Identifiers: *Manure**

**The primary objectives of this study were: (a) to characterize the chemical composition, with emphasis on nitrogen, phosphorus and potassium of old and fresh beef cattle manures, and (b) to evaluate the nitrate and salt status of farms receiving these manures. The nutrient concentrations in manures were found to be related to the degree and duration of manure exposure to climate. Thus manures from open-lot housing systems were found to have the lowest nitrogen and phosphorus concentrations. The most favorable evaporative conditions, present in open-lots, caused the lowest nitrogen concentration. (Carmell-East Central)**

2145 - E2 200

## UTILIZING THE NUTRIENTS IN ANIMAL MANURES

**Department of Crop and Soil Sciences, Michigan State University**
**L. W. Jacobs**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, p. 85-100, 3 fig. 5 tab. 10 ref.**

**Descriptors: *Animal waste, *Soils, *Chemical properties, *Physical properties, Nutrients.**
**Identifiers: Plant-soil environment. Land disposal, Application rates**

**A plant nutrient can be used by a crop, become part of the soil complex, leach down through the soil profile within drainage water, be washed away by runoff and erosion, and/or volatilize and be lost as a gas. To consider the various plant nutrients in view of these five factors, the text included discussions of some physical and chemical properties, the chemistry of nutrients in soils, and the problems encountered in maximizing the rates of manure applications. It was concluded that the most practical method of animal manure disposal is application to soils, The soil-plant environment provides the best means for utilizing the potential value of manures. But like any other resources, the soil-plant environment must be properly managed to be the most effective. (Cartmell-East Central)**

2146 - A1, B1 200

## LICENSING CONCERNS FOR THE TRANSPORATION OF ANIMAL WASTES

**Chief, Solid Waste Management Division, Environmental Protection Branch**
**F. B. Kellow**
**Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 101-103.**

**Descriptors: *Animal wastes, *Transportation, *Regulations *Waste management, *Licensing, Spillage, Pollution control**

**Today the transportation of waste is not without the lack of equipment. There are now special roll-off containers, portable and stationary compaction units that will increase by at least 3 times the quantity of material that can be moved in a 40-cubic yard container. Collection vehicles can now grind their waste prior to com-**

paction to increase the load capacity. Large scale animal production facilites must be considered as industries and therefore be under the environmental controls instituted for the protection of the people. This would require the licensing and control of the transportation vehicles used to transport animal wastes along the highway for any operation providing products for more than the immediate farm family. The requirements set up for the proposed licensing of these transportation vehicles are briefly discussed. (Cartmell-East Central)

2147 - A1, E1 200

### PENDING LEGISLATION RELATED TO AGRICULTURAL WASTE

Michigan Department of Agriculture
D. R. Isleib
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 105.

Descriptors: *Michigan, *Legislation, *Waste water disposal *Land disposal

With regard to pending legislation, two bills are briefly described. Bill HB 4614 provides for regulation of toxic substance applications to land used or intended for use for agriculture by the Michigan Department of Agriculture. SB 1245, would establish local and state control over waste water disposal programs by the Corps of Engineers. It would require that both local government and the legislature approve plans for waste water disposal on land. (Cartmell-East Central)

2148 - A1 200

### ANIMAL WASTE IMPACT ON RECREATION WATERS

Water Quality Appraisal Section, Michigan Department of Natural Resources
R. Waybrant
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 107-108.

Descriptors: *Animal wastes, *Water pollution, *Recreation

The impact of animal waste on the quality of recreational surface waters will depend upon the constituents of the animal waste and the character of the receiving water. The general recreational aspects including swimming, fishing, and boating, are considered in this presentation along with the known changes or impact that individual constituents of animal waste will cause in a given situation. (Cartmell-East Central)

2149 - A1, B1 200

### ACCEPTABLE SOLUTIONS TO POTENTIAL WASTE POLLUTION SITUATIONS

Department of Agricultural Engineering, Michigan State University
R. L. Maddex, T. L. Thorburn, C. Harvey, P. Koch, and P. Shutt
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 109-133. 8 fig.

Descriptors: *Livestock, *Poultry, Odor, Agricultural runoff, Costs
Identifiers: *Pollution abatement, Waste handling

Six examples of livestock and poultry facilities were selected for discussion by the panel. Suggested pollution prevention or abatement practices were recommended. Overlays of each example and the recommended waste handling systems were prepared and projected on the screen for presentation and discussion. A brief summary of the discussion is included. (Cartmell-East Central)

2150 - A1, B2, D4, E3 200

### FLUSHING SWINE WASTE

Department of Animal Husbandry, Michigan State University
E. C. Miller
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, May 22-23, 1974, p. 133-134.

Descriptors: *Aeration, *Recycling, Odor, Costs
Identifiers: *Swine, *Flushing, Slotted floors, Pits

A flushing system was installed at a Michigan State University swine research farm. Experience has shown that the flushing trench under a slotted floor should have a minimum of 2 percent slope. The surface of the trench should be troweled as smooth as possible and a good urine resistant concrete sealor applied. Experiments are in progress involving the aeration of the waste by a new mechanical device for forcing oxygen into the liquid under pressure. The aerated material is then recycled to be used as the sole source of drinking water and for reflushing. The performance of the pigs has not been consistently good but the results indicate that the feeding of recycled waste has a definite potential. (Cartmell-East Central)

2151 - A5, B1, D4 200

### AGRICULTURAL POLLUTION CONTROL LABORATORY

Agricultural Engineering Department, Michigan State University
J. B. Gerrish
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, Michigan, May 22-23, 1974, p. 137.

Descriptors: *Bacteria, *Hydrogen sulfide, Methane, Odor, Lagoon, Wastewater
Identifiers: Swine, Anaerobic conditions, Purple sulfur bacteria

A project is underway to mass-cultivate purple sulfur bacteria. These photosynthetic bacteria have the ability to consume hydrogen sulfide under anaerobic conditions. Hydrogen sulfide is probably the most obnoxious component of odor coming from a wastewater lagoon. Another project involves methane production from hog manure. There are two facets of methane that will be investigated: the removal of hydrogen sulfide from the gas and matching gas production with energy utilization. (Cartmell-East Central)

2152 - D2 200

### HANDLING, DEHYDRATION AND UTILIZATION OF POULTRY WASTES

Department of Poultry Science, Michigan State University, East Lansing
J. C. Zindel
Agricultural Waste Conference Emphasis-Animal Waste, Kellogg Center, Michigan State University, East Lansing, Michigan, May 22-23, p. 145 146.

Descriptors: *Dehydration, *Poultry, Recycling, *Design data, Demonstration project, Construction, Laying house, Waste removal, Excreta

A demonstration project was undertaken to design, construct and test a poultry laying house that would incorporate a complete system for waste removal and dehydration of the excreta. The excreta was removed daily and placed in a drying tunnel. The exhaust air from the ventilation system was directed over the excreta for approximately 24 hours in the drying tunnel before machine dehydration. Fresh excreta was voided at 80 percent moisture. Average moisture content of excreta when placed in the tunnel and also just prior to machine dehydration varied with the ventilation rate. (Cartmell-East Central)

2153 - A1, B1, C1, D1, E1, F1 200

### NATIONAL SYMPOSIUM ON POULTRY INDUSTRY WASTE MANAGEMENT

Nebraska University
National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963.

Descriptors: *Poultry, *Waste treatment, *Waste storage, *Waste disposal, Odor, Costs, Design, Water pollution
Identifiers: *Pollution

A national symposium on poultry industry waste management was held at Nebraska University with the primary purpose of learning as much as possible about the problems of poultry waste management. Among topics considered were: sanitary landfills, lagoons, dehydration, incineration, odor, water pollution, recycling, land disposal, and refeeding. Symposium participants attempted to discuss and identify waste disposal methods that were economically feasible, mechanically possible, and socially acceptable. (Cartmell-East Central)

2154 - A5, A8, B1 200

### WASTE MANAGEMENT PROBLEMS ON THE FARM

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 5 p.
C. E. Ostrander

Descriptors: *Poultry, Spreading, Spraying, Hydraulic collection, Odor, Climates
Identifiers: *Waste management, Flies

The waste problem is not one of merely removing the manure physically, but includes eliminating odors and finding a way actually to dispose of this material in a sanitary manner. Engineers have shown that we are producing 278,000,000 pounds of poultry manure every day. In some areas where the climate is not dry enough to dry the droppings under the cages, poultry producers dry the wastes in yards by thin spreading. Still others liquefy the droppings by making a slurry and then thin spread it layer by layer by spraying. This allows accumulation over a period of several months without fly development. In warm climates and where open houses are used, flies can be a major problem. Flies have not been as much of a problem in closed houses. Odors are a problem with closed houses and cool climates. Odors are a major reason for the rapid development of hydraulic collection in many areas. Besides holding down odors, the hydraulic system gives the poultryman more flexibility in spreading or disposal. There are odors from the hydraulic system when cleaning, but cleaning is less frequent. Disposal of dead birds is another problem that needs attention. (Cartmell-East Central)

2155 - A5, A8, C2, C3, D2 200

### FOWL FECAL FACTS

S. A. Hart
Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 13 p. 9 fig. 4 tab, 10 ref.

Descriptors: *Poultry, *Physical properties, *Chemical properties, Biochemical oxygen demand, Moisture content, Nutrients, Odor, Organic matter, Drying
Identifiers: *Excreta

Poultry manure is voided as a single product; kidney excretions are combined with the feces. The amount of solids defecated per day depends upon the quantity and quality of the feed ingested, and upon the efficiency of metabolism. Chicken manure has a specific gravity of approximately 1.75. The solids in manure are of two kinds—organic (usually called volatile solids) and inert (referred to as ash). What really makes manure a problem is its biological properties. Chicken or turkey manure contains a great deal of organic matter readily useable by lower life forms. Manure nourishes billions of microorganisms, and can serve as a food source for fly larvae. The standard measure of stability or putrescibility of wastes, including manure, is biochemical oxygen demand (BOD). Chicken excrement amounts to 0.015 lb. BOD hen-day. To the farmer or health authority, the most important biological characteristic of poultry manure is its capacity to culture fly larvae. Manure is a prime breeding medium for flies because it consists of moist nutritious organic matter. Drying is one way of greatly reducing the attractiveness of manure to flies. (Cartmell-East Central)

2156 - A1, B2, D4, E1 200

### MANURE DISPOSAL LAGOONS

H. J. Eby

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 18 p. 4 tab. 33 ref.

Descriptors: *Lagoons, *Waste treatment, *Waste disposal, *Chemical properties, *Physical properties, Biological properties, Site selection.
Identifiers: Loading rates

The physical, chemical and biological aspects of the functioning of a manure lagoon are presented. Situations wherein a lagoon is not practical and factors influencing lagoon sites are given. A biological waste treatment process is limited in efficiency by the capabilities of the biological population. The important physical factors affecting the population of a stabilization pond are temperature, light, specific gravity and hydrostatic pressure. The specific gravity of an organiism present in the stabilization pond will determine whether the organisms will have a tendency to float, remain suspended or settle. The important chemical factor in a stabilization pond environment are the nutritional effects, the pH effects, and the toxic effects. The important biological factors in an environment are the inter-relationships of species, Although not a cure-all for manure disposal, where conditions are tight and where proper management is practiced, a lagoon can be a satisfactory means of manure disposal. (Cartmell-East Central)

2157 - A1, B2, C1, D4 200

### INDOOR LAGOONS FOR POULTRY MANURE DISPOSAL

Nebraska University
J. L. Adams

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 16 p. 7 tab.

Descriptors: *Lagoons, Poultry, *Waste disposal, Odor, Performance, Nitrogen, Ventilation, Design
Identifiers: *Slat floors, Flies

Based on experiments with microlagoons placed under poultry cages, it appears that cubage is the primary consideration in predicting the interval of time between cleanouts. Under the conditions of the experiment, there were no beneficial effects of heating the tanks. The reaction of both the slat floor indoor lagoon and the "microlagoons" tended to range from slightly acid to slightly alkaline with the mean pH being 7.5 for the 20 week microlagoon experiments. The large amount of water (315 cu. ft. per bird) afforded a reservoir of heat which was useful in leveling out quick decline in temperature. Aeration produced no beneficial effect on bacterial digestion. After one year of operation, the dried contents of the slat floor lagoon contained about 2.5% nitrogen. The odors produced by the slat floor house during 23 months of operation did not reach an intensity objectionable to caretakers or visitors and were not detrimental to performance of the birds. Odor and taste panels evaluated eggs left in the lagoon house for 36 hours. Off odors could only be detected on dirty eggs and this was true of both slat floor, lagoon and litter houses. Washing the dirty eggs removed the odors. No odors were detected in any eggs after shells were removed, whether raw or cooked.

2158 - B1, C1, D4 200

### DIGESTION OF FARM POULTRY WASTES

E. P. Taiganides

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 14 p. 3 fig, 10 ref.

Descriptors: *Anaerobic digestion, *Poultry, *Waste treatment, *Sludge digestion, *Design, Costs, Fertilizers, Gases
Identifiers: Loading rates

The anaerobic digestion process as a method of treating poultry wastes is discussed. One method of treatment of concentrated organic wastes that has been found satisfactory in municipal and industrial wastes is the process of sludge digestion. Sludge digestion is a biological process during which the organic matter is decomposed by anaerobic bacterial organisms. The anaerobic digestion process differs in many respects from other types of fermentations. The most important difference is that it is neither necessary to use a pure culture of bacteria nor to maintain such a culture for innoculation or reinnoculation. The quality and quantity of gas produced and the rate of decomposition are affected by temperature, the loading rate and the solids concentration of the waste fed to the digester; the accessibility of the substrate; the detention period; and the concentration of volatile acids in the digester. The main advantages, design considerations and cost figures based on manufactuured sludge digestion equipment for different size digesters are presented and discussed briefly. (Cartmell-East Central)

2159 - A5, A8, B2, E2 200

### PROGRESS REPORT ON MANURE HARVESTING

H. R. Davis and A. T. Sobel

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 14 p. 11 fig.

Descriptors: *Poultry, *Liquid wastes, Waste Storage
Identifiers: *Waste handling, *Semi-liquid wastes, Transporting, Field spreading

The difference between liquid and semi-liquid waste handling systems for poultry droppings is discussed. Specific methods and equipment are described for handling wastes utilizing caged, slatted, and tiered systems for raising poultry. The transition from a semi-liquid to a liquid system is a natural alternative due to reduction of flies, odors, and repetitive labor requirements. Methods for removing manure to the spreading device, transporting device, or storage are described. Handling the manure in a semi-liquid form requires some device similar to a conventional barn cleaner. For manure in liquid form, the use of pumps is practical. Augers and open troughs have been used to move both semi-liquid materials and liquid materials, using faster speeds for the latter. Liquid manure can be moved into storage by gravity or by a combination of gravity and flushing. The type of handling system used determines the method used for field spreading or the transporting of manure. When in a semi-liquid form, conventional spreaders can generally be used. Liquid spreading requires a different type of spreader. A side delivery type has the advantage of working for all forms of manure, whether semi-liquid or liquid. (Cartmell-East Central)

2160 - B3, C1, D1, E3 200

### DEHYDRATION AND INCINERATION OF POULTRY MANURE

Department of Agricultural Engineering, Cornell University
D. C. Ludington

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 15 p. 5 fig.

Descriptors: *Dehydration, *Incineration, *Poultry, *Equipment, *Costs

Two possible methods of disposal of poultry manure are dehydration and incineration. Dehydration is one method of changing the physical properties of poultry manure so that it is no longer offensive and still retains much of its original nutritive value. The major problems are odor and dust conditions in and around the dehydration point. For analysis of the costs involved in dehydrating poultry manure, a hypothetical processing plant was designed and studied. Because of the uncertainty of a market for pelleted manure and the high cost of fuel for dehydration, incineration of the manure was investigated. In this way the heat of combustion of the manure could be used to reduce the fuel costs. In order to analyze the process of incineration, many of the physical, chemical and thermal properties of the manure had to be known. A research project was initiated to ascertain these properties. If a mechanical dewatering device could remove the free water, incineration might be the most economical method of disposal. Dehydration cannot be economical unless the product can be sold for at least $30 per ton. (Cartmell-East Central)

2161 - E2 200

### AGRICULTURAL VALUE OF POULTRY MANURE

R. S. Dyal

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 15 p. 7 tab, 22 ref.

Descriptors: *Poultry, *Organic matter, *Costs, *Fertilizers, Nutrients, Nitrogen
Identifiers: *Land spreading

The purpose of this paper is to estimate the supply of manure from laying hens, broilers, and turkeys; summarize data on its plant nutrient and organic matter contents; and discuss its value as a fertilizer and for soil improvement. About 33.4 million tons of manure from laying hens, broilers, and turkeys was voided in 1960. Poultry manure is generally higher in plant nutrients, particularly nitrogen, than other farm manures. With the factors of availability taken into consideration, the value of plant nutrients contained in manure from broilers, laying hens, and turkeys voided in different litters varied from $3.15 to $16.40. The most profitable method of manure disposal is spreading accumulations of solid manures on cropland, especially where land is available. (Cartmell-East Central)

2162 - A2, A4, E2 200

### WATER POLLUTION PREVENTION

T. L. Willrich

Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 8 p. 20 ref.

Descriptors: *Water pollution, *Groundwater, Livestock, Poultry Agricultural runoff, Nitrates, Microoorganisms, Percolation, Pathogenic bacteria

Disposal of livestock and poultry wastes onto or below the ground surface presents a potential source of surface and ground water pollution. Either a high coliform bacteria or nitrate test result indicates an existing or a potentially hazardous water supply for domestic use. Many individual well water supplies test unsafe for human consumption. Nature is the best ally in water pollution prevention. Many microorganisms fail to reproduce and survive outside of their natural habitat, the body of an animal. Most pathogens are believed to die rapidly in ground water. Nitrates appear to be one of the more serious chemical pollutants resulting from the biological decomposition of animal wastes. Nitrate poisoning appears to be confined to infants during their first few months of life. The specific source of nitrates causing pollution in a particular well may be difficult to positively identify. Water percolating through the soil carries nitrates with it. Pollution prevention can be accomplished best by assisting natural purification processes. In spreading wastes, thin, dilute, expose to sun and oxygen or other destructive environmental conditions, and filter slowly. (Cartmell-East Central)

### 2163 - A1, B1 200

### PUBLIC HEALTH ASPECTS OF POULTRY WASTE MANAGEMENT

R. J. Black
Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 3 p. 1 ref.

Descriptors: *Public health, *Poultry, Costs, Dusts, Aesthetics
Identifiers: *Waste management, Flies, Noise

Each segment of the poultry industry—including hatcheries, broiler ranches, egg ranches, and processing plants — produce different types of wastes which create a variety of problems. From the public health standpoint, these problems frequently result in complaints from nearby residents concerning odors, fly production, water pollution, dust, noise, rodent attraction, and aesthetics. Another problem that has concerned the poultry industry and public health workers is salmonellosis. Continued infection of flocks is costly to the poultryman and carries over to the product. (Cartmell-East Central)

### 2164 - A5, A8, E2 200

### SANITARY LANDFILLING OF POULTRY WASTES

Division of Environmental Engineering & Food Protection, Public Health Service, U. S. Department of Health, Education & Welfare, Washington, 25, D. C.
R. J. Black
Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 5 p. 5 ref.

Descriptors: *Poultry, *Landfills, *Solid wastes, Costs
Identifiers: *Manure, *Sanitary landfill operations, Hauling distances, Flies

There are two types of sanitary landfill operations of interest to the poultry industry in disposing of such poultry wastes as manure, feathers, litter, carcasses, and offal. They are (1) the public sanitary landfills that are operated for the disposal of refuse and other solid wastes, and (2) the sanitary landfills that are operated for only the disposal of poultry wastes. Costs of operation, types of wastes accepted, methods of financing, and user charges vary widely, so that local conditions and hauling distances must be investigated to determine the feasibility of utilizing sanitary landfill facilities for the disposal of poultry wastes. There are two phases of fly control work that are important in the operation of sanitary landfills: (1) preventing further oviposition, and (2) preventing fly emergence. Laboratory tests have shown that no reasonable amount of uncompacted cover would prevent fly emergence, since houseflies emerge through five feet of uncompected earth cover. Field tests have shown that under usual field conditions, a 6-inch layer of compacted cover prevented fly emergence. (Cartmell-East Central)

### 2165 - B3, D4 200

### UTILIZATION AND DISPOSAL OF POULTRY MANURE

J. S. Wiley
Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 12 p. 13 ref.

Descriptors: *Poultry, *Waste disposal, Aeration, Moisture content, Nutrients, Decomposition
Identifiers: *Composting

Farming and agricultural industry have expanded in the sense that individual installations have become larger while smaller establishments have been relinquished or consolidated. With this expansion has come the increasing problem of waste management. One method of handling wastes while they must be stored is by composting. Present-day composting is the aerobic, thermophilic decomposition of organic wastes to a relatively stable humus. Decomposition is done by the biological activity of microorganisms which exist in the wastes. A wide variety of organic wastes may be treated by composting but the raw mixture must meet certain requirements and the undertaking requires a certain amount of "know-how" and attention. Adequate aeration means the provision of enough air so that there will be some excess of oxygen to provide aerobic conditions at all times throughout the mass. Proper moisture content has perhaps the top rating of all criteria for optimum composting. A reasonable range of nutrients is necessary for both plant and microbial life to thrive and produce. The easiest of chicken manures to handle is the deep litter manure from ranches where the birds are on the floor. (Cartmell-East Central)

### 2166 - A5, A6, D1 200

### ODORS AND AIR POLLUTION

C. V. Wright
Presented at National Symposium on Poultry Industry Waste Management, Nebraska Center for Continuing Education, University of Nebraska, Lincoln, May 13-15, 1963, 5 p.

Descriptors: *Wastes, *Poultry, *Air pollution, *Odor
Identifiers: *Odor control, *Odor detection, Chicken wastes

For purposes of air pollution control, odors may be classified into two broad categories: source and ambient odors. Source odors are those at their point of origin; ambient odors are distributed into the general atmosphere by air currents. The characteristics of greatest concern for odor control are the quality, strength, and occurrence of an odor or odors. The human organoleptic system must be used as the basic tool for odor detection and classification. No mechanical devices have been developed for this purpose as yet. Control of odors generally must be designed either to counter the cause, or to treat the emissions. Most odors are gaseous emissions and there are five proven methods for treating these types of odors. These are: combustion, absorption, adsorption, masking, and counteraction. The problems and recommendations from several plants processing feathers and other chicken waste products are given. (Cartmell-East Central)

### 2167 - A1, B1 400

### PLANNING FEEDLOT WASTE DISPOSAL

Anonymous
Wallaces Farmer, Vol. 97, No. 22, p. 86, January 1972.

Descriptors: *Planning, *Feedlots, *Waste disposal, *Waste storage, *Design, *Costs, *Locating
Identifiers: *Soil Conservation Service, *Runoff, Livestock operations, Technical assistance

When a farmer builds a feedlot or any type of livestock facility, he must be certain it's not going to cause a pollution problem. Usually the farmer will work with the Soil Conservation Service (SCS) in planning to build these new facilities. The SCS has long been involved in conservation projects like terracing, long-term seedings, and tilling. It is now playing a big role in planning and designing feedlot runoff controls and waste storage systems for livestock operations. According to the state conservation engineer for SCS, there are two ways a farmer can get help from the SCS. A farmer can sign a cooperative agreement with his soil conservation district. Or he may apply directly to his ASCS Committee for cost share benefits and be referred to the SCS. In both cases the SCS can provide technical assistance in planning and locating feedlot runoff facilities and waste storage areas. Once the facility is built, an SCS representative checks the work, then submits final approval to the ASCS and cost share payment is made. (Cameron-East Central)

### 2168 - D1, E3, F1 200

### THERMOCHEMICAL EVALUATION OF ANIMAL WASTE CONVERSION PROCESSES

Chemical Engineering Department, Texas Tech University, Lubbock
J. E. Halligan and R. M. Sweazy
Presented at 72nd National Meeting, American Institute of Chemical Engineers, St. Louis, Missouri, May 21-24, 21 p. 3 fig, 5 ref.

Descriptors: *Recycling, *Gases, *Oil, *Cattle, *Economics, *Feasibility studies
Identifiers: *Thermochemical evaluation

On a dry basis, cattle manure has a heat content of 4000 to 7500 Btu/lb. That of coal is 12,500. Thermochemical calculations for conversion of manure to methane gas, oil, and synthesis gas are detailed. On the basis of a manure output of seven pounds of manure (dry) per day from 600,000 cattle, all product streams would have values which total about $9000 a day. The cattle population (600,000) chosen is that within fifteen miles of a point near Hereford, Texas. Methane gas production would require oxygen costing $4276 per day on the basis of the authors' price assumptions. "As gas prices increase, this process may become feasible at some locations. A considerable amount of further development would be required to make oil production—which requires 380° C temperatures and 6000 psig pressures—economically feasible. "The production of synthesis gas suitable for feed to an ammonia plant appears to have the most promise at this time due to the simplicity of the process and the value of the product." (Whetstone, Parker, and Wells-Texas Tech)

### 2169 - A1, B1, D1, E1 100

### AGRICULTURAL SANITATION OF LIVESTOCK MANURES FOR CONTROL OF FLIES, ODORS, AND DUSTS

Department of Entomology, California University, Davis, 95696
E. C. Loomis
Journal of Milk and Food Technology, Vol. 36, No. 1, p. 57-63, 1973. 2 tab, 16 ref.

Descriptors: *Livestock, *Feedlots, *Dairy industry, *Flies, *Odor, *Dusts, Economics, Insecticides, Deodorants, Sprinkling
Identifiers: *Pollution control, *Waste management

The co-existence of agriculture and suburbia has brought the problems of flies, odor, and dust under close scrutiny. Because wastes (sewage, livestock wastes, and domestic wastes) are produced in such vast quantities and because flies, odors, and dusts resulting from agricultural activities are a matter of public health concern, cooperative research programs have been made involving interdisciplinary personnel representing federal, state, and local agencies in line with state and local codes and ordinances governing control of fly, odor, and dust problems. The most commonly accepted method of fly control has been the use of insecticides and adulticides. Buf flies have developed a resistence to many of these, thus causing stronger chemicals to be used. Agricultural people have had to turn to better manure management practices to supplement insecticide use. Dust problems have been fought by such methods as sprinkling of oil products, application of wood shavings, and sprinkling with water. Odor has been fought through use of deodorants, enclosed confinement, and better management practices. Thus, physical, mechanical, biological and chemical methods may be combined to beat these problems, but one big problem still remains—money. Livestock owners must find a way to defray the costs of implementing these pollution control measures. (Merryman-East Central)

2170 - B1, D1 100

### DIFFUSION OF CATTLE MANURE SOLUTION THROUGH A WET POROUS STRATUM WITH REACTION

S. K. Choi, L. T. Fan, L. E. Erickson, and R. I. Lipper
Water, Air and Soil Pollution. Vol. 1, No. 4, p. 390-404, 1972.

Descriptors: *Diffusion, *Cattle, *Mathematical models, *Chemical oxygen demand, Porous media, Water pollution sources
Identifiers: *Manure, *Stratum, Pollution, Solution

Research was done to investigate, under simulated conditions, the transport rate of cattle manure through a wet porous stratum while the manure is consumed by microorganisms in both the porous body and the adjacent body of water. To prepare the cattle manure solution for use in the experiments, the manure was mixed with a large amount of water. During a period of three days, it was agitated several times: After settling for two days, the solution was filtered three times to remove suspended manure particles. Experimental observations were made to determine the diffusion coefficient and the biological reaction rate constant of the manure solution. Values of approximately 6.76 x 10(6) cm (2) s (-1) for the diffusion coefficient and 3.05 x 10 (-2) day (-1) for the reaction rate constant of 25 +/—2°C were obtained. (Cameron-East Central)

2171 - B2, E2 400

### SLICK DISPOSAL SETUP-DAIRYMAN DESIGNED IT

Successful Farming, Vol. 73, No. 5, p. K4, March, 1975. 3 fig.

Descriptors: *Waste disposal, *Lagoons, Water, Dairy industry, Odor
Identifiers: *Holding pit, Flushing, Manure

With advice from a University of Missouri dairy and agricultural engineering specialist, Charles and Clem Schabbing have designed and installed a labor-saving manure disposal system. The Schabbings use a utility tractor and blade to scrape manure into a holding pit from their new free-stall barn. The pit is located in the corner of a sloping concrete pad extending from the barn and connecting with a holding area adjacent to the milking parlor. Twice a day waste is flushed from the holding area into the pit, using water pumped from the lagoon. Vented so a vacuum can't form, the pit empties as fast as the liquid manure can rush through the 6-in. buried plastic pipe. The Schabbings report there is almost no odor, certainly not enough to be offensive. (Cameron-East Central)

2172 - D2, E3 400

### RECYCLED WASTE IN FEEDS DESCRIBED

Feedstuffs Southeastern Correspondent
R. H. Brown
Feedstuffs, Vol. 46, No. 49, p. 34, December 2, 1974

Descriptors: *Recycling, *Farm wastes, *Feeds, Cattle, Poultry, Florida, Alabama
Identifiers: *Refeeding, *Waste management, Swine, Fiber, Waste fat

Dr. W. B. Anthony, of Auburn University, told feedmen at the Florida Feed Conference that one day in the near future, feed manufacturers will be using an animal waste product in commercial feeds. There are at least two ways to manage animal waste for feed. One is to take components and process them and put them back into feed. Early work at Auburn was to take animal waste from cattle, put it over a screen, wash it and recover the fiber and use that as an animal feed. Washed fiber is now being used in many areas, especially dairies, using a flush-down system which eliminates the fiber from water-treating processes. Anthony related the latest trials in Alabama with yearling cattle. Animals were on test 112 days, ending July 15 and slaughtered seven days later. According to Dr. R. L. West of Florida, increased use of yield grading and proposed changes in grading systems by the USDA are steps in the right direction toward solving problems of today's waste fat in beef carcasses. (Cameron-East Central)

2173 - E4, F1 300

### PAUNCH CONTENT-BLOODMEAL MIXTURE AS PROTEIN SUPPLEMENT IN FEEDLOT RATIONS

J. K. Matsushima, C. Byington, and W. E. Smith
Beef Nutrition Research, Colorado State University Experiment Station, General Series 934, p. 42-44, May, 1974

Descriptors: *Feeds, *Proteins, Feedlots, Drying, Cattle, Costs
Identifiers: *Paunch content, *Bloodmeal, Cottonseed meal

When paunch content and blood meal are dried and blended in equal proportions, the protein content is similar to cottonseed meal (45% protein) or other similar protein supplements commonly used in feedlot rations. Research was done in an attempt to compare the feeding value of dried paunch content-bloodmeal mixture with cottonseed meal as a protein supplement in feedlot rations. Three treatments (protein supplementation) involved in this trial were: (1) control or cottonseed meal; (2) paunch content-bloodmeal in equal proportions (on dry basis); and (3) a 50:50 mixture of cottonseed meal supplement with paunch content-bloodmeal mixture. The supplements were fed at the rate of 0.75 lbs. per head daily. The results of the feeding trial show that paunch contents from packing plants where fat cattle are slaughtered primarily can be used advantageously if dried and blended with dried bloodmeal. When used as a protein supplement, the cattle will consume it readily and support the protein needs in feedlot rations. (Cameron-East Central)

2174 - A1, B1, E2 200

### A SYSTEMS APPROACH TO CATTLE FEEDLOT POLLUTION CONTROL

Department of Chemical Engineering, Texas Tech University, Lubbock
G. F. Meenaghan, D. M. Wells, and E. A. Coleman
Presented at the 72nd National Meeting, American Institute of Chemical Engineering, St. Louis, Missouri, May 21-24, 1972. 29 p. 24 fig. 5 tab.

Descriptors: *Cattle, *Feedlots, *Water pollution control, Air pollution, Fertilizers, Land disposal, Irrigation, Chemical properties
Identifiers: Slotted floors, Soil injection

Very simple and relatively low-cost solutions are available for the problem of water pollution caused by cattle feedlots. Vastly more complex and difficult problems to solve are the air pollution and solid waste disposal problems resulting from conventional feedlot operations. Farmers do not generally consider it to be economically feasible to use manure as fertilizer. Hence, about the only option open to most feedlot operators for disposal of solid waste is to provide a large tract of land on which the waste can be stored more or less indefinitely Veritable mountains of manure exist these mountains are frequently ignited by spontaneous combustion, thereby providing an additional significant source of air pollution. A nearly ideal feedlot, that of the Green Valley Cattle Company at San Marcos, Texas, is described. It has slotted floors over pits cleaned daily, is completely roofed, and provides for irrigation by means of a 2000-gal. capacity honeywagon equipped with chisels which dispose of the manure below surface thus avoiding the otherwise inevitable odor and fly problems. (Whetstone, Parker, and Wells-EPA)

2175 - A2, A4, A5, B2, E2 600

### THE DESIGN AND OPERATION OF AN OPEN-FRONT, SLOTTED FLOOR BEEF CONFINEMENT BUILDING

Area Extension Engineer, Illinois University
M. D. Hall and F. McRoberts
Presented at 1969 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 9-12, Paper No. 69-911, 3 p.

Descriptors: *Design, *Confinement pens, Costs, Waste disposal, Ventilation, Cattle, Agricultural runoff, Fertilizers, Performance
Identifiers: *Waste management, *Feeding systems, Slotted floor

In using confined feeding systems, practically all feeders are looking for the same thing: (1) profit on animals going through the system, (2) minimum labor and management requirements, (3) minimum odor and waste disposal problems, and (4) provision of a market for feed that is not easily marketable. There are four basic components to any feeding system that must be fit together: (1) feeding system, (2) waste disposal system, (3) environmental system, and (4) animal handling system. The system studied was designed with a bunk feeding system. The waste disposal system consisted of a slotted floor with a pit under it to catch the waste and pumps to remove it. The main objective with the environmental system used was to prevent drafts, keep the cattle dry in the winter and provide good shade with the best natural ventilation possible. Performance of cattle in the open-front confinement cattle barn was excellent when compared with cattle in conventional feedlots. No significant health problems were experienced with the inside or outside cattle, and the open-front solar-type beef barn should work well in almost any climate with minor changes. The manure was concentrated with no runoff, allowing maximum use of manure as fertilizer and also allowing control of ground water pollution to some extent. (Battles-East Central)

2176 - B1 100

### RECYCLING, ENERGY AND AGRICULTURAL ECONOMICS

Assistant Professor of Economics, California State University, Chico
M. Perelman
Compost Science, Vol. 14, No. 5, p. 26-27, September October, 1973.

Descriptors: *Recycling, *Economics, *Agriculture, *Energy, Transportation, Organic wastes.
Identifiers: Production

Professor Michael Perelman expounds upon the inefficient output of energy to produce less energy in the form of food. In terms of energy recycling capabilities, America's agricultural system is not as efficient as those in many other countries. The production and transportation systems used are wasteful and poorly integrated, thus increasing energy loss. Furthermore, there is a tremendous amount of energy included in waste products that is not being utilized. What is needed is a system of small farms integrated into their communities so that people can live in a close cycle, where a quality of the environment and a quality of life can be maintained. (Battles-East Central)

## 2177 - B1, D2, D4, E2, E3 300

### RECYCLING POULTRY WASTE AS FEED: WILL IT PAY?

Economic Research Service, U. S. Department of Agriculture
R. Gar Forsht, C. R. Burbee, and W. M. Crosswhite
Agricultural Economic Report No. 254, March 1974, 51 p, 1 fig, 33 tab, 61 ref.

Descriptors: *Recycling, *Feeds, *Economics, Incineration, Drying
Identifiers: *Refeeding, *Dried layer waste, Broiler waste, Land, disposal, Anaerobic lagoons, Aerobic lagoons, Oxidation ditch, Composting

The costs and return of feeding recycled dried layer waste (DLW) [illegible] livestock and poultry are compared; less information is available on recycling broiler waste. Alternative poultry-waste management systems are also compared. For flock sizes of 80,000, 50,000, and 10,000 cage layers, the cost of producing and feeding of 1 ton of DLW is $25, $30, and $46, respectively. On-farm processing and feeding of DLW do not appear to be economically feasible for the 10,000 layer operation. However, it may be feasible for the larger operations. The highest net returns are attained by the larger operations when DLW is fed at 12.5 percent of the ration. Since a layer operation can only incorporate a portion of the poultry manure back into feed, alternative disposal systems must still be considered, and disposal and anaerobic lagoon treatment are the least expensive alternative poultry-waste management systems. Mechanical drying, aerobic lagoon treatment, oxidation ditch treatment, and combined anaerobic-aerobic lagoon treatment fall within the intermediate cost range. Composting and incineration are the most expensive. Layer waste can also be dried and fed to dairy and beef cattle and broiler waste—both ground and ensiled—has been fed to dairy and beef cattle. Rations containing up to 30 percent DLW have been fed to dairy and beef cattle without significant problems. Both ground and ensiled broiler wastes have been fed to dairy and beef cattle with little effect on carcass quality. (Battles-East Central)

## 2178 - B2, E2, F1 600

### MANURE SLURRY STORAGE, PROCESSING, AND PUMPING

Vice President, AGPRO, Inc., Santa Rosa, California
D. J. Gribble
Presented at 1967 Winter Meeting, American Society of Agricultural Engineers, Detroit, Michigan, December 12-15, 1967, Paper No. 67-926, 4 p.

Descriptors: *Waste storage, *Pumping, *Slurries, Sprinkler irrigation, Cost, Equipment, Dairy industry
Identifiers: *Processing.

When AGPRO developed its manure-flush system in 1962, there was still one problem to solve—60 to 100 gallons of water, waste grain, hay, bedding, and manure per cow per day also had to be disposed of. Hauling was not practical because of the volume, and the sprinkling systems available were not meant to handle large amounts of solids, and particularly long material such as hay and straw. Work and experimentation led to the development of the AP-100 Series High Pressure Manure Slurry Processing and Pumping Plants. These units meet requirements by using a combination of equipment. (1) They utilize a high pressure pump delivering the slurry through conventional irrigation tubing to a special rubber nozzled field sprinkler. (2) They contain a processing unit that will reduce all normal foreign material such as hay, bedding, feed, etc., to a size that will pass through the pump and sprinkler head. (3) The cost of purchase and operation of the plants is less than the tractors, manure spreaders, hydraulic loaders and other equipment that they replace. However, research is yet to be done on the economics and mechanical features involved in distribution of manure by means of high pressure pumps and sprinklers. (Battles-East Central)

## 2179 - A2, A4, C1 600

### THE EFFECT OF FARM WASTES ON THE POLLUTION OF NATURAL WATER

Agricultural Engineering Department, Wisconsin University, Madison
S. A. Witzel, N. E. Minshall, E. McCoy, R. J. Olsen, and K. T. Crabtree
Presented at 1969 Annual Meeting, American Society of Agricultural Engineers, Purdue University, West Lafayette, Indiana, June 22-25, 1969, Paper No. 69-428, 24 p.

Descriptors: *Farm wastes, *Water pollution, *Waste disposal, Denitrification, Nitrification, Nitrates, Soil profiles, Groundwater pollution, Nutrients, Agricultural runoff, Feedlots, Irrigation, Fertilizers
Identifiers: *Waste handling

Results are given of studies concerning the enrichment of natural surface and sub-surface waters by animal wastes. The studies expose the possibility of adverse trends in waste handling already developed producing a critical situation in some areas. Areas researched through use of the 2500 samples of water collected included: (1) biological nitrification, (2) biological denitrification, (3) migration of nitrates in soil profiles as a source of nitrates in sub-surface waters, (4) effect of agricultural practices on groundwater quality, (5) groundwater pollution in the Rib Falls Community, (6) nutrient losses on one small Lake Mendota Watershed, and (7) nutrients in base flow of Southwestern Wisconsin streams. Conclusions drawn from the studies were: (1) nutrient losses in the base flow of southwestern Wisconsin streams during this period of high winter runoff totaled only 25 percent as much N and K and 10 percent as much P as in the suurface runoff, (2) heavy manure applications in the vicinity of farm buildings or large feedlots can result in dangerously high nitrate concentrations in farm wells, (3) heavy supplemental irrigation, combined with repeated heavy nitrogen fertilizer applications may result in an increase in the nitrates in groundwater, (4) heavy annual application of manure and/or fertilizer can raise the groundwater to the toxic level of nitrates, and (5) continuous records of nitrate levels in selected rural wells will indicate any adverse conditions, hopefully, in time to permit effective corrective measures to be taken or to prepare for alternative sources of supply. (Battles-East Central)

## 2180 - D1, E3 200

### HYDROGASIFICATION OF CATTLE MANURE TO PIPELINE GAS

Pittsburgh Energy Research Center, U. S. Department of the Interior, Bureau of Mines, Pittsburgh, Pennsylvania
K. Kiang, H. F. Feldmann, and P. M. Yavorsky
Presented at the 165th National Meeting, American Chemical Society, Dallas, Texas, April 8-13, 1973, p. 15-23, 3 fig. 2 tab. 4 ref.

Descriptors: *Gases, *Recycling, Cattle, Autoclaves, Carbon dioxide, Hydrogen, Oil
Identifiers: *Hydrogasification, Reactors, Tar

In this report, experimental data are discussed showing the quality and yield of pipeline gas that can be generated by directly reacting cow manure with hydrogen at gasification conditions. Except for one experiment conducted with dried cow manure in a continuous free-fall dilute-phase reactor, the experiments with manure and solid wastes were conducted in a batch autoclave. The autoclave body was fitted with a pyrex glass liner into which the autoclave charge was placed and a thermocouple was inserted into the liner. The autoclave was assembled and weighed and then installed in an electric furnace which heated the autoclave at a rate of 8 degrees C per minute. Experiments were conducted at temperatures of 475, 550 and 650 degrees C. At temperatures low enough to allow appreciable yields of ethane, the cattle manure was readily converted to pipeline gas by hydrogasification and tars or oils were produced. It's possible to produce a SNG with a heating valve in excess of 1,000 Btu/scf by simply hydrogasifying the manure, shifting a rather low concentration of CO to $CO_2$, and scrubbing out $CO_2$ without any need for methanation. Manure placed in the continuous free-fall dilute-phase reactor was more reactive than it was in a batch reactor because of much higher heatup rates and the low concentration of particles in the dilute-phase reactor. (Battles-East Central)

## 2181 - A5, B1, D4, E2 700

### AEROBIC STORAGE OF DAIRY CATTLE MANURE

C. M. B. Robson
M. S. Thesis, Department of Civil Engineering, Purdue University, June, 1963, 51 p. 1 fig. 28 tab., 17 ref.

Descriptors: *Waste storage, *Aerobic conditions, *Dairy industry, Odor
Identifiers: *Land spreading, *Loading rates, Volatile solids, Kjeldahl nitrogen

Field spreading of dairy cattle manure is the most generally used method of disposal in the north central United States. When spreading is not feasible, the manure must be stored. Research was thus prompted concerning aerobic storage of dairy cattle manure. The manure was stored at 4° and 24° C at loading rates of 60, 80, 100 and 120 grams of manure per day per 4 liter storage volume. The suitability and accomplishments of storage were measured by the analytical procedures, total and volatile solids, chemical oxygen demand, and total kjeldahl nitrogen. The intensity of odors was evaluated. The following conclusions were reached: (1) Of the loading rates tested, the amount of loading did not influence the degree of degradation. (2) volatile solids decreased 20 percent at 4° C and 42 percent at 24° C. (3) Appreciable amounts of material with a chemical oxygen demand were removed during aerobic storage. (4) Kjeldahl nitrogen content, per gram of total solids, of the material remaining after aerobic storage is higher than kjeldahl nitrogen content, per gram of total solids, of the raw manure. (5) Foaming was a major problem. (6) Aerobic storage holds promise of minimizing odor problems encountered in spreading unaerated material after storage. (Merryman-East Central)

## 2182 - A1 200

### NITRATE PROBLEMS IN PLANTS AND WATER SUPPLIES IN MISSOURI

G. E. Smith
Presented at Second Annual Symposium on the Relation of Geology and Trace Elements to Nutrition, 92nd Annual Meeting American Public Health Association, New York City, October 7, 1964, 36 p. 9 tab., 28 ref.

Descriptors: *Nitrates, *Nitrites, *Nitrogen, *Water, *Missouri, *Toxicity, *Water pollution, *Soil contamination, *Ground water pollution, Leaching, Feedlots, Sampling, Fertilizers, Aquifer, Wells, Public health, Surface waters
Identifiers: *Plants, Cyanosis

Progress on research for sources of nitrogen which result in excess nitrate-nitrite in plants and water in Missouri is reported. Water samples were collected from 5000 sources (both rural and urban) from 45 counties that represent nine distinct geologic areas in Missouri. All samples were tested qualitatively for nitrites by the sulfanilic acid method. Forty-two percent of the 5000 sources surveyed contained over 5 ppm of nitrate-nitrogen. Soils in feedlots were sampled and some were found to contain concentrations of nitrates up to 330 p/a of nitrogen to a depth of 10 ft. Both deep wells and spring waters were found to contain nitrates. Analyses were made of vegetable crops. Intake of nitrate from vegetables was not large. (Cartmell-East Central)

### 2183 - B2, C5, D4, F1 100

### ANAEROBIC DIGESTION OF DAIRY FARM SLURRY

Department of Biological Sciences, Surrey University
C. Bell
Effluent and Water Treatment Journal, Vol, 13, No. 4, p. 232-233, April, 1973.

Descriptors: *Dairy industry, *Anaerobic digestion, *Slurries, Methane, Costs
Identifiers: *Pilot scale anaerobic digestor

Merrist Wood Agriculture College has designed and constructed a pilot scale anaerobic digestor. Sixty liters of a 1:7 faeces/water mixture is fed to the reactor chamber once every 18 days. The slurry is digested at 35 degrees C for 18 to 21 days, after which time a displacement effect pushes the digested material into the primary oxidation tank and eventually to a disposal pit. The main advantages are mechanization of manure handling, prevention of loss of nitrogen from raw manure, control of the loss of organic matter from manure, the destruction of weed seeds during digestion, and recovery of methane gas. (Battles-East Central)

### 2184 - D4, E3 100

### METHANE PRODUCTION FROM WASTE

University College, Cardiff
D. A. Stafford
Effluent and Water Treatment Journal, Vol. 14, No. 2, p. 73-79, Feb., 1974.

Descriptors: *Methane, Methane bacteria, *Sewage, *Waste treatment, *Anaerobic digestion, Farm wastes, Microbiology, Fuels, Gases, Inhibitors

Much of the fundamental microbiology of the organisms involved in methane production is not understood. It is known that methane bacteria share common properties. They all grow only in the absence of oxygen and they all have narrow substrate requirements, Methane can be produced by two stage hydrolysis/gas production anaerobic digestion plants, but sometimes these digesters cease their hydrolysis and subsequent gas production. The reasons are not always clear. It is known that there are inhibitors to digester gas production (ie. copper inhibits anaerobic digestion of pig waste), but much is yet to be learned. Much research is needed if we are ever to reap the benefit of using domestic sewage as a source of power. (Merryman-East Central)

### 2185 - D1, E3 200

### PRELIMINARY FLOW SHEET AND ECONOMICS FOR PRODUCTION OF AMMONIA SYNTHESIS GAS FROM MANURE

Department of Chemical Engineering, Texas Tech University, Lubbock
W. S. Wideman, J. E. Halligan and H. W. Parker
Presented at 76th National Meeting of American Institute of Chemical Engineers, Tulsa, Oklahoma, March 10-13, 1974, 20 p. 3 fig. 6 tab. 12 ref.

Descriptors: *Economics, *Ammonia, *Synthesis, *Farm wastes, Recycling, Feed lots, Fertilizers, Oxidation, Costs
Identifiers: *Flow Sheet, *Production, *Manure, Char, Sulfur, Waste management.

The need for ammonia in the United States has increased at a tremendous rate in the past few years. New processes for the production of ammonia synthesis gas are being examined to meet the rising costs of conventional natural gas feedstocks. One process, the partial oxidation of cattle feedlot wastes to produce the synthesis gas, has been under investigation at Texas Tech for the past year. The long term goals of the project were designed to complement the agricultural economy of the High Plains area of Texas, in that cattle wastes would be disposed of by conversion into ammonia fertilizer, which in turn is used in the production of cattle feeds. In terms of solid waste disposal, the investment cost of the process is $4,625 per daily ton of manure processed, but in terms of production, the investment becomes $10,165 per daily equivalent ton of ammonia. This project has been shown to be technically and economically attractive. For this reason, along with the probability of more restrictions on natural gas feedstock supplies, continued development of the process is advisable. (Russell-East Central)

### 2186 - B2, D4, E2 100

### HANDLING MILK-PARLOR WASTE

Department of Microbiology, Otago University Dunedin, New Zealand
R. G. Bell, and J. B. Robinson
Canadian Agricultural Engineering, Vol. 14, No. 2, p. 56-58, December, 1972.

Descriptors: *Dairy industry, *Farm wastes, *Cattle, *Waste treatment, *Waste storage, *Waste disposal, *Aeration, *Canada, Chemical analysis, Odor, Chemical oxygen demand, Septic tanks, Lagoons, Irrigation, Nitrogen, Hydrogen ion concentration
Identifiers: *Milking-parlor wastes

A study was undertaken to assess the treatability of a typical milking-parlor effluent by aeration to help determine the most feasible disposal method for the watery waste. Four day's aeration of milking-parlor waste produced a clarified effluent with a BOD of 200 parts per million. This effluent was not of a sufficiently high standard for direct discharge into a water course. It was concluded that aeration, followed by surface water discharge, and septic tank disposal are unacceptable practices for disposal of milking-parlor waste in Ontario. Storage in an aerobic lagoon combined with spray or furrow irrigation is a feasible alternative but is hampered by the winter conditions prevailing in the province. Where the manure is already being handled as a liquid, the most satisfactory alternative would appear to be combining the milking-parlor waste with the manure where liquid storage is available. (Cartmell-East Central)

### 2187 - A4, A9, E2 100

### NITRATES IN SOIL AND GROUND WATER BENEATH IRRIGATED AND FERTILIZED CROPS

United States Department of Agriculture, Fresno, California
H. I. Nightingale
Soil Science, Vol. 114, p. 300-311. 1972. 6 fig. 7 tab., 12 ref.

Descriptors: *Nitrates, *Soil contamination, *Groundwater pollution, *Irrigation, *Fertilizers, *California, *Farm wastes, Cattle, Poultry, Septic tanks, Soils, Analysis

An area of 334 sq. mi. in Fresno County, California, was studied intensively for nitrates beneath irrigated and fertilized crops. The fertilizers used included steer and chicken manure. "No harmful effects, from the health standpoint, will be encountered even if present fertilizer practices are continued Continued uncontrolled 'suburban' expansion with its septic tank systems and a shift in agricultural production from crops (grapes, etc.) with low N requirement to truck and orchard crops with higher nitrogen requirements may be a cause of concern." (Whetstone, Parker, Wells-Texas Tech University)

### 2188 - A6, B2 700

### AIR POLLUTANTS IN SWINE BUILDINGS

Oklahoma State University, Stillwater, Oklahoma
D. L. Lebeda

Descriptors: *Air pollution, *Swine, *Confinement pens, *Farm wastes, Gases, Chemical analysis, Toxicity, Ventilation, Bacteria, Sampling, Carbon dioxide, Sulfur dioxide, Hydrogen sulfide, Ammonia
Identifiers: *Swine buildings, Air borne bacteria

Objectives were to determine the concentrations of ammonia, hydrogen sulfide, carbon dioxide, and air borne bacteria within a swine building with fluid waste handling, and to relate the concentration of gases to the management, ventilation, and building parameters of a confinement building. The absorption method was used in determining all of the gases, and none of the gas concentrations determined were above the threshold level for humans. The average carbon dioxide concentration was from 2, to 2.5 times higher than the normal atmospheric level of 300 ppm. The average gas concentrations with ventilation were 8.1, 0.27, and 0.025 ppm of ammonia, hydrogen sulfide, and sulfur dioxide, respectively. Without ventilation, in six hours the gas concentrations were three times the two-week values, with ventilation, for ammonia and hydrogen sulfide and six times that for carbon dioxide. The average number of air borne organisms found was 4,800 per cubic feet. What is needed now is a study to determine both the chronic and acute level of gas concentration on confinement animals. (Russell-East Central)

### 2189 - C1 100

### DIGESTION OF POULTRY MANURE BY MUSCA DOMESTICA

Department of Animal Sciences, Colorado State University, Fort Collins
B. F. Miller, J. S. Teotia, and T. O. Thatcher.
British Poultry Science, Vol. 15, p 231-234, 1974. 2 tab.

Descriptors: *Digestion, *Farm wastes, *Poultry, *Aeration, Larval growth stage, Larvae, Temperature, Moisture, Protein
Identifiers: *Manure, *Musca domestica

Research was undertaken to evaluate the ability of Musca domestica to grow on poultry manure to stabilize and yield useful, easily harvested products to combat this problem. As temperature was increased from 17 to 38°C, the time required to develop from egg to pupae was decreased from 11 to 5 days, The optimum level of inoculation was found to be from 0.5 to 1 g of house fly eggs per kg of fresh manure. Larval development significantly modified poultry manure. Approximately 80% of organic matter in the manure was destroyed during tho developmental period. Fifty-eight per cent of the moisture was lost while the mineral content was not changed significantly. The physical consistency of the manure became somewhat granular and could be dried readily because of the increased surface area, small particle size and improved aeration. The residue was stabilised and was not nearly as offensive as the fresh material. The residue contained about 15% protein after the pupae were removed. (Cartmell-East Central)

### 2190 - A2, B1, F4 100

### AGRICULTURAL RUNOFF—CHARACTERISTICS AND CONTROL

Cornell University, Ithaca, New York
R. C. Loehr
Proceedings Paper No. 9406, Abstract No. 5042, ASCE Sanitary Engineering Division Journal, Vol. 98, No. SA 6, p. 909-925, December, 1972.

Descriptors: *Agricultural runoff, *Control, Erosion, Feed lots, Farm wastes, Livestock, Pollutants, Ponding, Chemical characteristics, Fertilizers, Nutrients

Identifiers: Land disposal

Some pollution problems due to agricultural runoff are discussed and put into perspective. Erosion, rural runoff, and fertilizers are discussed in detail. Pollution contributions from feed lots and land used for manure disposal can have the largest concentrations but are intermittent and are able to be controlled by the use of good management practices. Contributions from crop land are more difficult to control although possibilities exist through the use of better timing of fertilizer applications and soil conservation practices. Pollutional contributions from many rural areas can be due to natural, geological, and soil conditions. Range, pasture, and woodland are diffuse sources that represent background or natural contributions that will be extremely difficult to control. This comparison of contaminant sources indicates that not all agricultural contributions are insignificant and some may require control. (Cartmell-East Central)

2191 - D1, E1 400

### HOW EGGMEN ARE SOLVING THE ECOLOGY PROBLEM

Department of Poultry Science, Cornell University, Ithaca, New York
C. E. Ostrander
Poultry Tribune, p. 28, 32, 36, 2 fig.

Descriptors: *Poultry, *Ecology, *Waste storage, *Waste treatment, *Waste disposal, Recycling, Odor, Dehydration, Drying, Lagoons, Oxidation lagoons, Aerobic conditions.
Identifiers: *Eggmen, Soil injection, Isolation

A noted authority on waste management outlined a number of approaches that are being used to solve poultry pollution problems. Among them are: (1) use of in-house drying, (2) liquid systems-untreated and oxidation system, (3) lagoons-natural and aerated, (4) soil injection, (5) dehydration, and (6) isolation. While each of these approaches has its advantages, no one specific method will fit every situation. (Cartmell-East Central)

2192 - A1, F2 100

### COMMERCIAL FEEDLOTS—NUISANCE, ZONING AND REGULATION

D. J. Paulsen
Washburn Law Journal, Vol. 6, p. 493-507, 1967, 80 ref.

Descriptors: *Feedlots, *Nuisance, *Zoning, *Regulation, Commercial, Agriculture, Air pollution, Water Pollution, Pests, Odor, Abatement, Livestock, Legal aspects,
Identifiers: Noise, Injunction.

Livestock feedlots are not public nuisances, per se, but they may become nuisances by virtue of their operation or the manner in which they are kept. Each case must of necessity be decided by examination of all the facts and circumstances surrounding the particular alleged nuisance. Among the facts and circumstances to be considered are: the type of neighborhood, the nature of the complaint, the proximity of those alleging the injury, and nuisance frequency. The remedies for nuisance are damages at law and injunction or abatement in equity. Zoning and regulation by public agencies are methods used to control the location and operation of feedlots, but because most zoning laws and regulations are the product of agrarian oriented legislatures, feedlots have been exempted to a certain degree from zoning and regulations by statute. A trend is starting in the East, however, to consider commercial feedlots (as opposed to the usual farm feedlots) as being more in the nature of an industry. This impetus is expected to spread. (Ballard-East Central)

2193 - A1, D2, E1 100

### TAKING CARE OF WASTES FROM THE TROUT FARM

R. Jenson
National Fisherman, Vol. 52, No. 9, p 15-A, February, 1972, 9 fig.

Descriptors: *Fish hatcheries *Trout, *Water pollution, *Settling basins
Identifiers: *Fish wastes, *Waste disposal, *Solids removal

After development of obnoxious conditions in the Jordan River near a picnic area, the Jordan River Watershed Committee asked the Jordan River National Fish Hatchery near Alba, Michigan, to correct the undesirable river conditions. It was determined that solid wastes from the hatchery were causing the problem. After studying solids removal attempts of Lamar National Fish Hatchery Development Center in Lamar, Pennsylvania, the Jordan River National Fish Hatchery set about designing its own settling basin. Important factors to be considered were retention time, weight of wet solids, water velocity and distribution, and depth of water. The final design consisted of two compartments, each of which had two trenches connected to a manhole pump which would separate and trap the solids. The wastes were then to be disposed of in one of the following ways: (1) as direct applied land fertilizer, (2) in a sewage disposal system, (3) as raw material for commercial fertilizer, (4) by transfer to a municipal sewage plant, or (5) by incineration. (Merryman-East Central)

2194 - A5, B2, D3 600

### TREATMENT OF LIQUID HOG MANURE TO SUPPRESS ODORS

Illinois University, Urbana
W. C. Hammond, D. L. Day and E. L. Hansen
Presented at 1966 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 6-9, 1966, Paper No. 66-928, 14 p. 12 fig., 5 tab., 3 ref.

Descriptors: *Waste treatment, *Liquid wastes, *Odor, *Lime, *Chlorination, Anaerobic conditions
Identifiers: *Swine, *Sand bed filter

Liquid manure becomes anaerobic immediately when collected in pits beneath self-cleaning slotted floors. In this state, it supports anaerobic bacteria that produce objectionable odors. The possibility of adding lime and chlorine to liquid manure to prevent these gases and odors was investigated in this study in conjunction with sand filtering of the treated waste. The study showed that chlorination virtually stops the production of ammonia, hydrogen sulfide and methane and considerably reduces carbon dioxide production. Liming does not have much effect in controlling ammonia liberation but affects carbon dioxide and methane production. Neither methane or carbon dioxide produces an objectionable odor, but they both indicate changes in the digestion process with changes in concentration. About 0.15 to 0.16 pound of lime per 100-pound hog per day was found to be the amount necessary to maintain the desired pH. Costs of lime addition are given. Use of powdered calcium hypochlorite was discontinued when early attempts in mixing the chemical into waste were not satisfactory. Trapping solids and organic matter was effectively achieved by the sand-bed filter. BOD, COD and total solids were reduced to about half during the first passage through the sand-bed filter of the waste. (Kehl-East Central)

2195 - A1, B3, C2, C3, F1 600

### ROOFED VS. UNROOFED SOLID MANURE STORAGES FOR DAIRY CATTLE

College of Agricultural and Life Sciences, University of Wisconsin Experimental Farm, Ashland, Wisconsin
G. H. Tenpas, D. A. Schlough, C. O. Cramer and J. C. Converse
Presented at 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-15, 1972, Paper No. 72-949, 20 p., 5 fig., 11 tab., 7 ref.

Descriptors: *Waste storage, *Dairy industry, *Seepage, *Costs, Nutrients, Chemical properties, Physical properties

The University of Wisconsin Experimental Farm at Ashland has investigated for three winters the solid storage of manure from a stanchion type dairy barn. The structure was roofed for the third year of the trial. Results on the unroofed structure have been given previously by Cramer, et. al., 1971. The manure handling facilities included an extension to the barn cleaner elevator, horizontal distribution conveyors, a 13,000 cubic ft. bunker type manure storage, and a 3000 cu. ft. detention pond. Floor drains allowed the liquids to seep into a sampling tank and detention pond for storage. The study showed that the chemical and physical characteristics of the manure were not affected by the addition of the roof. The total amount of stack seepage was reduced by 34% by the addition of the roof, although the quantity of summer seepage was largely due to less evaporation under the roof. Several disadvantages of the roof are increased cost and greater difficulty in servicing the barn cleaner drive unit and other conveyors. Another disadvantage is that although the buildup of manure on the conveyors did not cause a problem; it did not thaw as readily. Volume measurements were made on manure production, including stored volume of solids, seepage and bedding and these are provided in tables. Also given are the results of laboratory analyses of the fresh manure, stored manure and seepage. (Kehl-East Central)

2196 - A1, B1, D1, E1, F1, F2 300

### FEEDLOT WASTE MANAGEMENT: WHY AND HOW

Missouri River Basin Animal Waste Management Pilot (Steering) Task Group.
Environmental Protection Agency Report, Kansas City, Missouri, June, 1971, 45 p. 10 fig.

Descriptors: *Feedlots, *Legal aspects, Terracing, Lagoons, Design, Water Pollution control, Odor
Identifiers: *Waste management, Location, Mounding, Settling channels, Holding ponds, Technical assistance, Financial assistance

Basic information on the problem of cattle feedlot waste management and the pollution arising from these operations is presented in a non-technical manner. The factors that cause feedlots to pollute and the magnitudes pollutants may reach are discussed along with some management factors and structural and mechanical means to help control water pollution. Sources of technical assistance in design and layout of control facilities and the water pollution control agencies for the ten Missouri River Basin states are listed. Existing animal waste control regulations are also furnished for these ten states. (Missouri River Basin Animal Waste Management Pilot (Steering Task Group)

2197 - D1, E2, E3, F1 100

### CHANGING FROM DUMPING TO RECYCLING. PART III: COMPOSTING AND MISCELLANEOUS PROCESSES

C. G. Golueke
Compost Science, Vol. 13, p. 5-7, May-June, 1972.

Descriptors: *Recycling, *Organic Waste, Economics, Aeration, Moisture content, Temperature
Identifiers: *Composting, *Land disposal, *Refeeding, Pyrolysis, Carbon-nitrogen ratio, Particle size.

"Composting is the biological decomposition of organic matter under controlled conditions." Consideration must be given to aeration, moisture content, temperature, carbon-nitrogen ratio, and particle size. Manure can be composted in 8 to 14 days without undue difficulty. A mixture of manure and sawdust or straw makes an excellent compost. Land disposal may be employed directly if the assimilatory capacity is not exceeded, or may be employed for the sludges produced by the other methods. Use of organic wastes in animal feedstuffs holds great promise provided that the possibility of bacterial and viral transmission is thoroughly explored, that the concentration of toxic materials is investigated, and that Food and Drug Administration approval is secured. Pyrolysis "is as yet in the reseach stage." Assorted fermentations are under investigation "At present, the economics of the processes are highly unfavorable." (Whetstone, Parker, & Wells-Texas Tech University)

2198 - A5, B1, D4 600

### STORAGE OF POULTRY MANURE WITH MINIMUM ODOR

Department of Agricultural Engineering, Purdue University, Lafayette, Indiana
D. C. Ludington, D. E. Bloodgood, and A. C. Dale
Presented at 61st Annual Meeting, American Society of Agricultural Engineers, Detroit, Michigan, December 12-15, 1967, Paper No. 67-932, 19 p. 8 fig., 4 tab., 3 ref.

Descriptors: *Waste storage, *Poultry, *Odor, *Oxidation reduction potential, Aeration, Hydrogen, sulfide

Air pollution with objectionable odors produced from stored poultry manure has become a recognized problem in much of the United States. Changes in animal management, increased concentrations of animals and increased proximity between people and poultry operations has caused these odors to become more pronounced and less tolerable in the past few years. The main objective of this study was to find the means of reducing or eliminating stored poultry manure odors. This paper contains the results of two main tests. These tests were replicates of each other for statistical analysis. The study showed that the ORP (oxidation-reduction potential) of stored manure was automatically controlled by regulating the rate of aeration. When chicken manure was stored without aeration, significant quantities of hydrogen sulfide were produced; insignificant quantities of hydrogen sulfide were produced with aeration. The only procedure for obtaining a meaningful measure of degradation is the analysis of all the chamber contents. It was impossible to obtain accurate measurement of low concentration of dissolved oxygen in fluid chicken manure. (Kehl-East Central)

2199 - A1, B1, F2 600

### STATE REGULATIONS PERTAINING TO LIVESTOCK FEEDLOTS

Livestock Engineering and Farm Structures Research Branch, U. S. Department of Agriculture, Beltsville, Maryland
W. F. Schwiesow
Presented at 1971 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 7-10, 1971, Paper No. 71-919, 16 p.

Descriptors: *Regulations, *Feedlots, *Livestock, *Water pollution

The need for water pollution regulation led to the establishment of water quality standards through the Water Quality Act of 1965. Through some rather unusual channels, the need to include the livestock feedlot industry became apparent. Investigations on fish kills and polluted streams established that feedlots and dairy farms were a major cause. A focus on livestock wastes as a pollution source drew attention to the need for changes in agricultural practices. This brought about livestock feedlots now being subject to water quality control regulations. Need for uniformity in these regulations is recognized and various reasons are given. A listing of state offices that may be contacted for additional information on such regulations is provided. (Kehl-East Central)

2200 - A6, B1 100

### THE INFLUENCE OF VENTILATION ON DISTRIBUTION AND DISPOSAL OF ATMOSPHERIC GASEOUS CONTAMINANTS

Department of Agricultural Engineering, Alberta University, Edmonton, Alberta
P. G. Brannigan and J. B. McQuitty
Canadian Agricultural Engineering, Vol. 13, p. 69-75, December, 1971, 8 fig., 3 tab., 15 ref.

Descriptors: *Ventilation, *Gases, *Air pollution, *Distribution patterns, *Model studies, *Waste storage, *Liquid wastes, Temperature, Carbon dioxide, Ammonia
Identifiers: *Piggery, *Swine

"This study investigated the effects of ventilation on the mean concentrations and the distribution patterns of atmospheric ammonia and carbon dioxide in an enclosed chamber representing a full scale section of a pig barn. Results showed no practical differences between the distribution patterns of ammonia and carbon dioxide. Ventilation rate was the only independent variable of importance in determining the concentrations of either gas. Under non-isothermal conditions, ventilation outlet height has a negligible effect on gas concentrations. An increase in gas concentrations from stock in the diffusion of gases in the atmosphere was apparent." (McQuitty & Barber-Alberta University)

2201 - A5, B2, D4 600

### HOW ARE LAGOONS WORKING ON HOG FARMS?

Illinois Department of Public Health, Division of Sanitary Engineering, Room 616, State Office Building, Springfield
C. E. Clark
Presented at 1964 Annual Meeting, American Society of Agricultural Engineering, Ft. Collins, Colorado, June 21-24, 1964, Paper No. 64-418, 12 p. 1 fig., 2 tab.

Descriptors: *Lagoons, *Design, *Waste disposal, Confinement pens, Illinois
Identifiers: *Swine, *Odor control, Flushing, Sievers System

Confinement hog feeding is a new mass production technique in agriculture. Complaints of odors and problems with waste disposal systems led the Illinois Department of Public Health to visit a few installations. This resulted in a survey of existing installations in which two major designs of waste disposal coupled with confinement methods were found. The Sievers System holds 200 hogs in one pen. The rectangular slab is sloped to a center trough on the long axis and a large part of the slab is flooded to a depth of a foot at the edge of the trough. The second type is an enclosed building broken down into smaller pens. The floor is slotted and underlain by a slab that is a concrete channel for flushing the waste to a lagoon. The study concluded that lagooning of hog waste is practical. Other methods do not appear to be economically feasible although they may be functional from the viewpoint of waste disposal. Design and maintenance of the confinement area should be considered in odor control since they are major factors. (Kehl-East Central)

2202 - B2, E1, F1 400

### NO PEN CLEANING COSTS!

J. Fetterolf
Beef, Vol. 11, No. 2, p. 16-18, October, 1974, 2 fig.

Descriptors: *Confinement pens, Cattle, *Kansas, *Waste disposal, *Lagoons, Economics, Performance

A Kansas feeder described his 2700-head confinement feeding facilities which he estimates will save $6500 a year in manure hauling. The facility has two slat sections through each of 12 pens and there are scrapers below the slats to clean the barn. The manure is pumped from the collection pit to a four-pond system, consisting of two primary and two secondary lagoons. This aerobic lagoon system handles itself except for periodic clean-outs. Only direct rainfall can get into the ponds because dike tops are above ground level. Other advantages of this type of confinement feeding include: (1) a one percent increase in yield of carcass weight, (2) feed savings due to no loss from storms or rains, (3) savings in veterinary costs, (4) the shelter will provide added warmth in winter and will allow an increase in feed utilization for finishing rather than in providing body heat for the animal, and (5) feed conversion and gain efficiencies should be better. (Merryman-East Central)

2203 - A1, B1, F2 400

### NUISANCE LAWSUITS — NEIGHBOR VS. NEIGHBOR

Successful Farming, Vol. 72, No. 10, p. 40, September, 1974.

Descriptors: *Legal aspects, *Waste treatment, *Waste disposal, Locating
Identifiers: *Nuisance lawsuits, *Bower vs. Hog Builders, Inc., *Pollution

Even if a livestock operation is not large enough for a permit to be required, the operation can still get into trouble concerning animal waste disposal. If a nuisance (the use of land by one that unreasonably interferes with the enjoyment or use of another's land) is created, a nuisance lawsuit may be brought against the operator. An example of this is the Bower vs. Hog Builders, Inc. case. In this instance, the Hog Builders, Inc. began a swine breeding and feeding operation adjoining the Bower Farm fifteen years after the Bowers had established their farm. This swine operation allowed effluent to flow onto the Bower's farm causing fish kills, odor, a difference in drinking water, and an influx of rats and flies. The Bowers lawsuit was submitted to a jury, and the Bowers were awarded $46,200 actual damages and $90,000 punitive damages. Such lawsuits can be avoided by locating such operations away from others' homes, by proper zoning, through licensing laws, and through construction of adequate waste treatment facilities. (Merryman-East Central)

2204 - A5, A6, B2 600

### AIR POLLUTANTS IN SWINE BUILDINGS WITH FLUID WASTE HANDLING

Agricultural Engineering Department, Illinois University, Urbana
D. L. Lebeda, D. L. Day and I. Hayakawa
Presented at 1964 Winter Meeting, American Society of Agricultural Engineers, New Orleans, Louisiana, December 8-11, 1964, 17 p. 14 fig., 5 tab., 15 ref.

Descriptors: *Air pollution, *Liquid wastes, Ammonia, Hydrogen sulfide, Carbon dioxide, Ventilation, Dimensional analysis
Identifiers: *Swine, Sulfur dioxide, Concentrations

One area of swine environment that has received little attention is air pollution caused by gaseous pollutions: Two main objectives of the study were: (1) Determine the concentrations of ammonia, hydrogen sulfide, carbon dioxide, sulfur dioxide, and air-borne bacteria in a swine confinement building with a fluid waste-handling system, and (2) Relate the concentration of gases to the management, ventilation, and building parameters of the building. The relationship of the air pollutants to the various pertinent quantities was described by dimensional analysis. A pair of totally slotted-floor pens with a common manure pit made up the unit. The volatile solids and the BOD of the swine waste collected in the manure pit were much lower than those found by Spillman. The initial addition of water to the manure pit was the main difference in the characteristic tests with swine waste. Therefore, more breakdown from oxidation and anaerobic decomposition was included in the lower loading rate due to dilution. The threshold level for humans was not exceeded by any of the gas concentrations. The study showed, however, that without ventilation, in six hours the gas concentrations in the experimental unit were three times the two-week values with ventilation for hydrogen sulfide and ammonia and six times the value for carbon dioxide. (Kehl-East Central)

2205 - A5, B2, D4 600

### THE AMELIORATION OF ODOUR AND SOCIAL BEHAVIOR IN, TOGETHER WITH THE POLLUTION REDUCTION FROM, A HOG HOUSE WITH RECYCLED WASTES

Agricultural Engineering Department, Iowa State University
R. J. Smith and T. E. Hazen
Presented at 60th Annual Meeting, American Society of Agricultural Engineers, Saskatoon, Saskatchewan, June 27-30, 1967, 19 p. 6 fig., 4 tab., 7 ref.

Descriptors: *Odor, *Social behavior (animal)
Identifiers: *Swine, Flushing, Anaerobic lagoon, Oxidation ditch, Waste management, Waste water reuse

Although confinement housing for finishing swine has brought many benefits, it has been found that certain new problems, specific to the system, have arisen. This study performed at Iowa State University covered three areas: (1) Odour level, (2) Social behaviour of the animal and (3) Waste management. The primary objectives of the study were (1) to establish the equipment which would allow the safe reuse of the treated waste water as the fresh manure transport vehicle, (2) the change in odour level and social behaviour and (3) to measure the properties of the fluid circulating round the system. The total scheme performance has proved satisfactory during the first six weeks of operation. A high quality effluent entirely suitable for utilization of the manure transport vehicle was provided by the combination of an anaerobic lagoon with an oxidation ditch. The odour level was appreciably lowered by the rapid manure transport from the building. The system of flushing at hourly intervals not only reduced the daily liquid flow through the pighouse but it also provided a source of interest for the pigs. Social behaviour was materially improved by this distraction. (Kehl-East Central)

2206 - A1, B1, D1, E1 200

### PRINCIPLES OF NUTRIENT CONTROL FOR AGRICULTURAL WASTEWATERS

Professor of Civil and Agricultural Engineering, Cornell University, Ithaca, New York
R. C. Loehr
Presented at Second National Symposium on Food Processing Wastes, Denver, Colorado, March 23-26, 1971, p. 603-613. 13 ref.

Descriptors: *Nutrients, *Control, *Waste water (pollution), Agriculture, Water pollution, Recycling
Identifiers: *Land disposal

Control of nutrients in agricultural discharges will become important in the near future as the nation's water resource policies receive greater scrutiny. Better data is needed concerning nutrient concentrations being discharged and processes that can be utilized for their control. Then technical decisions and cost estimates can be made. Among pollutant sources of concern are fruit and vegetable processing wastes; meat, poultry, and fish processing wastes, and animal manures. Pollution problems caused by nutrients in wastewater discharges include: (1) additional oxygen demand caused by reduced nitrogen compounds, (2) stimulation of aquatic plant growth caused by nitrogen, phosphorus, and other nutrients in wastewater, and (3) excess nitrates in groundwater as a result of wastes discharged on land. The two most feasible approaches for nutrient control are separation at the source, recovery, and recycle and land disposal. The success of recovery and recycle depends upon the use of the product; success of land disposal depends upon better knowledge of the land as a disposal media. (Merryman-East Central)

2207 - E3 100

### DIGESTION BY-PRODUCT MAY GIVE ANSWER TO ENERGY PROBLEM

Director of Environmental and Sanitary Engineering, Kaserle, Bender, Stone & Associates, Chicago, Illinois
J. Goeppner and D. E. Hasselmann
Water and Wastes Engineering, Vol. 11, No. 4, p. 30-35, April 1974, 6 fig., 2 tab.

Descriptors: *Energy, *Anaerobic digestion, *Methane, *Costs, *Recycling

Methane gas which is produced during the anaerobic digestion of sludge may be an answer to the energy problem. The volume of methane gas in anaerobic digestion is dependent upon the nature and volume of the fermentable wastes. Figures for methane production from sewage solids and garbage are given. The gas produced in general by anaerobic fermentation usually contains 60 percent to 70 percent BTU per cubic foot. Any favorable economics for using digestion units as an energy source are closely tied to the plant construction costs. The construction costs of anaerobic digesters and the operating and maintenance (O&M) costs associated with sludge digesters are dependent on size. Comparison of costs of such a method with other energy sources can be generated if a population of one million can be assumed. Such a comparison is given. A discussion considering animal wastes for such energy production is given. The Mechaelis-Menton kinetic model is used for aiming at a quantitative kinetic description of the process The importance of considering the location in relation to economics is stressed. Costs and gas value are discussed. Indications are that energy production from animal wastes is within the realm of economic reality. The need for more studies to be done and the importance of predicting the efficiency of the system are examined. (Kehl-East Central)

2208 - B2, E2 300

### USE OF CATTLE FEEDLOT RUNOFF IN CROP PRODUCTION

Kansas State University, Manhattan 66503
W. Wallington, L. S. Murphy, W. L. Powers, H. L. Manges, and A. Schmid
Report No. 1427, Kansas Agricultural Experiment Station, Manhattan 66506, p. 273-294. 11 fig., 3 tab., 10 ref.

Descriptors: *Feedlots, *Cattle, *Agricultural runoff, *Crop response, *Nutrients, Sampling, Kansas
Identifiers: Yield

Land disposal of beef-feedlot-lagoon (runoff) water was studied. Lagoon water was applied during the summers of 1970, 1971, 1972 and 1973 by furrow irrigation to a silty clay loam soil. After four years the five treatments averaged 0, 7, 13, 22 and 37 cm/yr. Corn (Zea mays L.) forage yield and plant content of N, P, K, Ca, Mg, and Na were measured. Surface soil samples and soil cores were taken from the plots after harvest each year. Electrical conductivity ranged from 1.6 to 7.6 (3.1 average) mmho/cm in the lagoon water applied at the study site and from 1.0 to 12.8 mmho/cm in samples taken from 12 Kansas feedlots. Electrical conductivities of extracts from saturated pastes of the surface soil samples were increased linearly by accumulative treatment all years. The 1970, 1971 and 1972 soil cores showed accumulation of $NO_3$-N, P, K, and Na in the top 30 cm at all treatment rates. Movement of $NO_3$-N and Na down to 100 cm was noted in 1971 in cores from plots receiving 43 cm/yr3. Movement of $NO_3$-N down to 240 cm was recorded in 1972 in cores from plots that had received 20 and 41 cm/yr. Extractable Ca and Mg in the soil cores was not affected by treatment. Corn forage yields were a linear function of treatment in 1970 and a quadratic function in 1971, 1972, and 1973. The positive effect on yield was attributed to increased soil fertility; the relative decreases at the higher rates were attributed to increased soil salinity. Maximum yield and uptake of N and P were reached at the 13 cm/yr. disposal rate in 1971 and 1972, and at the 22 cm/yr. rate in 1973. (Wallingford, et al-Kansas State University)

2209 - A1, B1, D1, E1, F1, F2 100

### AGRICULTURAL WASTE MANAGEMENT

Department of Agricultural Engineering, Oregon State University, Corvallis
J. R. Miner
Journal of the Environmental Engineering Division (Proceedings of ASCE), Vol. 100, No. EE2, February, 1974.

Descriptors: *Waste treatment, *Waste disposal, *Regulation, *Water pollution
Identifiers: *Waste management, *Pollution control, *Point sources, *Nonpoint sources, *Diffuse sources, *Land disposal

The sale price of agricultural products is established by a complex balance of supply and demand interacting with public needs and desires. This complex economic situation, plus the diverse climatic environments under which agriculture operates, creates a series of economic advantages and liabilities for feedlot operators. The design of waste management systems, to be economically feasible and technically effective, must be based on an appreciation of these factors. The principal functions involved in an agricultural waste management scheme generally include a collective system, a transport mechanism, a storage and treatment complex, and some means for ultimate reuse or disposal The management of animal wastes must be geared to these functions. Application of wastes to cropland is the most widely practical disposal method. Hence, treatment is usually for the purpose of making the manure more amenable to cropland application or for the purpose of changing its physical and chemical characteristics to avoid application difficulties or nuisances attributable to the application. (Merryman-East Central)

2210 - A1, B1, F2 400

### STEP-BY-STEP PLAN FOR LIVESTOCK WASTE CONTROL

W. Graves
Wallaces Farmer, Vol. 97, No. 4, p. 16-17, February 26, 1972.

Descriptors: *Livestock, *Iowa, *Feedlots, Regulation, Construction, Waste storage
Identifiers: *Waste management, Runoff control

The installation of a new livestock confinement setup or feedlot involves a farmer with a bewildering array of State and Federal agencies if his final construction is going to comply with regulations. In the State of Iowa, the first step is the extension service and perhaps the area livestock specialist. Iowa State University may also be able to help. The addresses of all these agencies and the sources of recommended pamphlets are provided in the text. The next step is to investigate water sources and possible pollution problems with the help of the Iowa Geological Survey. Then the Soil Conservation Service district office will provide the technical assistance necessary to draw up specific plans on locating and building runoff controls and waste storage facilities. Cost-sharing money is available from the Rural Environmental Assistance Program. Final plans and the finished installation must both be approved by the State Department of Health before cost-sharing money is paid. (Solid Waste Information Retrieval System)

2211 - A2, A4, E2 400

### TEST WAYS TO REDUCE FEEDLOT POLLUTION

Wallaces Farmer, Vol. 97, No. 8, p. 30, April, 1972.

Descriptors: *Feedlots, *Water pollution, *Groundwater pollution, *Agricultural runoff, *Slopes, *Management, *Sampling, *Basin, Nebraska, Engineering, Caissons

Management systems designed to limit runoff, handling of manure, and consequently pollution of streams and groundwater have been constructed and are under observation. These are new concepts of inexpensive runoff control from sloping feedlots. Cattle feedlots on slopes as high as 15% may become minimum polluters through the use of engineering and management. A feedlot near Omaha, Nebraska (on a steep 15% slope with one 350-ft. contributing slope length above the lone basin) and another near Springfield, Nebraska (with 2 basins on a 6% slope, with contributing slope length of about 120 ft. each) were studied. Soil and manure materials carried with the runoff were deposited in basins. Basins provided opportunity for the settling of suspended solids. Water from the ponds were used to irrigate nearby croplands. Runoff - recording equipment and groundwater sampling wells were installed on both lots. At Springfield, none of the groundwater samples have exceeded 10 parts per million of nitrate-nitrogen a figure the Public Health Service has set as minimum desirable limit in drinking water. (Cameron-East Central)

2212 - B2, D2 700

### HYDROLOGY OF ANIMAL WASTE WATER PONDS

A. W. Wieczorek
Unpublished MS Thesis, Agricultural Engineering Department, North Dakota State University, Fargo, 1973, 43 p. 12 fig., 10 tab., 19 ref.

Descriptors: *Waste water (pollution), *Ponds, *Hydrology, *Design criteria, *Evaporation, Cattle, Confinement pens, Precipitation (atmospheric), Liquid wastes, North Dakato, Agricultural runoff
Identifiers: *Animal wastes

Research was developed to obtain basic data needed to design systems that utilize solar energy to vaporize the liquid wastes from storage ponds. Reported in this paper are the results of an investigation conducted to determine a "pan coefficient" for the evaporation of animal waste waters. In addition, design criteria for evaporation ponds for the disposal of animal wastes are developed and evaluated. Climatological data for the past six years indicates that pan evaporation exceeds precipitation by 2.5 times per year. Design criteria for an evaporation pond based upon this study can be determined by using the following data: (1) drained liquid wastes production from a gravity flow system utilized in a confinement barn equals 0.0026 gallon per day per pound of beef feeder, (2) a Class A pan coefficient of 0.71 to 0.75 should be applied to obtain an accurate approximation of liquid waste evaporation, and (3) a factor of 1.7 times the annual rainfall to determine pond depth increase due to bank runoff. (Cameron-East Central)

2213 - B1, C2, C3, D4, E3, F1 300

### METHANE PRODUCTION FROM ANAEROBIC DIGESTION OF ANIMAL WASTES

Waterloo University, Waterloo, Ontario, Canada
W. D. Costigane, D. H. Edwards, D. A. Fraipont, G. R. McClean, J. H. Pinchin, and B. H. Younger
Project Report, University of Waterloo, Ontario, March, 1972, 105 p. 8 fig., 24 tab., 60 ref.

Descriptors: *Methane, *Animal wastes, *Anaerobic digestion, *Fuels, Sludge, Design, Costs

The purpose of this report is to investigate the nature and magnitude of environmental pollution from farm animal wastes and to design an anaerobic digestion system that stabilizes the waste, thereby reducing its pollutional effect. The destruction of pathogenic organisms and the production of usable products such as a combustible gas and a stable innocuous sludge are ancillary benefits achieved from the process. The anaerobic digestion system proposed in this report was designed to meet the following requirements: low capital cost, minimum maintenance and supervision and optimum waste stabilization and gas production. The total capital cost for the treatment system is $14,400. The sludge gas produced can be utilized as a fuel for heating, appliances and for running an automobile or tractor on the farm. The fuel savings obtained by the use of this gas can be applied against the cost of operating the waste treatment system. It has been estimated that a savings of $600 per year can be realized exclusive of depreciation on equipment. The anaerobic digestion system described in this report is not, at present, considered feasible for animal waste treatment on a small farm due to the high initial equipment cost. (Costigane, et. al.-University of Waterloo)

2214 - B2, F1 400

### LOW COST MANURE BASINS WORK IN WISCONSIN

R. E. Graves
Hoard's Dairyman, Vol. 120, No. 5, p. 290-292, March 10, 1975, 6 fig., 7 tab.

Descriptors: *Waste storage, *Wisconsin, *Basins, *Cost, *Dairy industry

Earthen storage basins or ponds for storing "liquid manure" are gaining popularity with Wisconsin dairymen. These basins allow long term storage with moderate to low investment. One-year storage allows manure spreading in late summer or fall on land which is to be plowed in the fall. This saves time during busy spring planting activities. It also provides a chance for freezing and thawing during winter to lessen the effects of soil compaction from the spreading operation. There are three basic types of storage basins. Type 1 is a rectangular with one long vertical wall which is usually concrete. It has an 8 to 10 foot paved strip along the bottom of the wall. A standard liquid manure pump may be used at any point along this wall. The remaining sides and most of the bottom are earthen. This is the most expensive type to build. Type 2 is a circular- or rectangular-shaped earthen storage with one or more pumping platforms or docks. Agitation and pumping may be done by a conventional liquid manure pump from platforms. Type 3 may be a circular- or rectangular-shaped with one or more ramps or driveways into them. Agitation and pumping is done with a modified liquid manure pump which doesn't have a right-angle gear box and is mounted horizontally from the three-point hitch of a tractor. (Merryman-East Central)

2215 - B1, F1 300

### A COMPARISON OF SOLID AND LIQUID MANURE STORAGE SYSTEMS

Agricultural Engineering Department, Wisconsin University, Madison
C. O. Cramer, J. C. Converse, G. H. Tenpas, D. A. Schlough, R. J. Johannes, et. al.
Technical Completion Report, Project 72-14 100-10, 090 (42) USDA, ARS, 40 p., 14 fig., 13 tab., 8 ref.

Descriptors: *Waste storage, *Solid wastes, *Liquid wastes, Wisconsin, Cattle, Costs, Dairy industry
Identifiers: *Semi solid wastes

This report is a summary of the work at the University of Wisconsin—Madison over the last few years on the three types of storages: solid storage, semi-solid storage, and liquid storage. The size of the storage depends on the number of days of storage, the number and size of animals, the type of manure, and the type and amount of bedding used. The types of solid storage systems described in detail include: bunker type storage, elevator type platform storage, thrower type platform storage, and summer time stacking. A number of storage designs have been built to handle semi-solid manure. Some units have been constructed below ground using sloping side walls with a ramp to remove it with a front end loader. The floor and walls are concrete. Others have been built above ground with side walls on all sides except for an opening with the floor sloping away from the opening. The types of liquid storage system described in detail include: free stall barn, slotted floor with under-barn tank, and manure scrape with outside storage. (Cartmell-East Central)

2216 - A5, A6, B1, C1 600

### CHEMICAL OXYGEN DEMAND AS A NUMERICAL MEASURE OF ODOR LEVEL

Minnesota University, St. Paul
J. D. Frus, T. E. Hazen and J. R. Miner
Presented at the 1969 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 9-12, 1969, Paper No. 69-929, 17 p., 5 fig., 6 tab., 8 ref.

Descriptors: *Chemical oxygen demand, *Gases, Ventilation, Temperature, Humidity
Identifiers: *Odor measurement, *Swine

The specific objectives of this project were: (1) To determine if the chemical oxygen demand (COD) technique could be used as a quantitative measure of the level of organic gases present in a confinement swine building atmosphere. (2) If successful, then to determine if the level of organic gases could be correlated with observed odor level, period of time animals are in the building, air temperature, relative humidity, rate of dilution by ventilation air, or characteristics of the waste. A satisfactory technique was developed to measure the COD of the atmosphere in a confinement swine building. Determination of what the air COD value included was not conclusive. The results indicated that COD values did not increase with the time the animals were in the building and there was no correlation between air COD and manure temperature, manure COD, air temperature, or relative humidity. There was an accumulation of organic gases within the chamber when essentially no dilution by ventilation air existed. Gases known to contribute to swine odor were shown to be oxidized by the potassium dichromate. (Cartmell-East Central)

2217 - B1, E3 300

### COMPARISON OF SOYBEAN MEAL, UREA AND DRIED CHICKEN MANURE AS PROTEIN SOURCES FOR GROWING CALVES

Minnesota University, St. Paul, Minnesota 55101
E. P. Cooper, R. D. Goodrich and J. C. Meiske
1974 Research Report B-204, P. 72-75, 3 tab.

Descriptors: *Feeds, *Proteins, *Performance, *Cattle, Ureas, Calcium, Phosphorus, Nitrogen, Nutrients
Identifiers: *Dried poultry wastes, *Soybean meal, Vitamin A

A feeding trial was conducted to compare rates of gain and feed efficiencies of growing heifer calves fed protein supplements that contained soybean meal, urea or dried chicken manure. The supplements were formulated to provide equal amounts of crude protein, vitamin A and trace mineralized salt and adequate amounts of calcium and phosphorus when fed at a rate of 3 lb. per day with a full feed of corn silage. Heifers that were fed soybean meal consumed the least amount of feed per day and per pound of gain; while those fed the chicken manure supplement consumed the most feed per day and per pound gain. Because the cattle fed chicken manure gained as well as those fed soybean meal or urea, it appears that the chicken manure used in this study provided adequate supplemental nitrogen to meet the needs of the heifers. Since amounts of feed per 100 lb. of gain were increased and the calculated TDN value was relatively low, it seems that chicken manure would be best used to provide supplemental nitrogen and not serve as a replacement for the grain portion of the ration. (Cartmell-East Central)

2218 - A1, B1, C3, F1 100

### DESIGN OF SOLID MANURE STORAGE FOR DAIRY HERDS

Agricultural Engineering Department, Wisconsin University, Madison
C. O. Cramer, J. C. Converse G. H. Tenpas,

D. A. Schlough
Transactions of the ASAE, Vol. 16, No. 2, p. 354-360, March-April, 1973. 3 fig., 10 tab., 11 ref.

Descriptors: *Design, *Waste storage, *Solid wastes, *Dairy industry, Nutrients, Odor, Sampling, Chemical analysis, Seepage, Costs
Identifiers: Fly breeding

A bunker type manure storage for a 32-cow stanchion dairy barn in northern Wisconsin was developed and studied as to its pollution potential, the preservation of plant nutrients and the management of the system. The manure handling facility consisted of an extension to the barn cleaner elevator, horizontal distributing conveyors, and a 3,000 cu. ft. retention pond. Floor drains were constructed to allow the liquids to seep into a sampling tank and retention pond for storage. Volume measurements were made on manure production, including bedding, stored volume and seepage. Laboratory analysis was made on fresh manure, stored manure, and seepage. The average total solids concentration of the fresh manure was 13 and 14 percent while the average COD concentration was approximately 123,000 and 140,000 ppm. The average total solids concentration of the stored manure was approximately 22 and 25 percent and the average COD concentration was approximately 222,000 and 231,000 ppm. The average concentration of total nitrogen ammonia, total phosphorous, and potassium was in the area of 5,500, 1,800, 1,500, and 4,800 ppm respectively. The total seepage collected, which included urine and precipitation, was 2.0 and 4.0 gal. per cow for the winter periods. The average BOD, COD, and total solids concentration for seepage in the winter periods was 13,000 mg per 1, 31,500 mg per 1, and 2.8 percent respectively. Odors from the storage were noticed at the residence only on damp overcast days when the wind blew toward it. Fly breeding was not a problem. (Cartmell-East Central)

2219 - A9, E3 300

### DIGESTIBILITY OF CATTLE FEEDLOT WASTE

Animal Science Department, Texas Tech University, Lubbock
R. C. Albin and L. B. Sherrod
Research Report No. 24, Texas Tech University Center at Amarillo, Pantex, Texas, March, 1974. 1 tab., 7 ref.

Descriptors: *Animal wastes, Cattle, Feedlots, Nutrients, Proteins, Composting
Identifiers: *Digestibility, *Refeeding

This project was conducted to determine the nutritive value of feedlot waste taken from Southwestern cattle feedlots where improved grain processing techniques and low levels of roughage are being used. Rations containing feedlot waste were offered to feeder steers in three total collection digestion trials. The steers were checked daily for health and stress symptoms. The results suggest that when feedlot waste is fed in high concentrate-adequate protein rations, little difference would be expected between raw and composted waste. The data also indicate that when the same waste is fed in a low energy-low protein ration, the waste would be digested to a greater degree than when fed with the high energy ration. Composting would decrease the digestibility of crude protein, but would increase cell wall digestibility in low energy-low protein rations. Data indicate that recycling cattle feedlot waste would not appreciably improve the problems of cattle waste disposal. There were no problems with feed consumption. The steers readily consumed even the 60% waste rations. No animal health problems were observed. (Cartmell-East Central)

2220 - A1 300

### SAMPLING BACTERIA IN A MOUNTAIN STREAM

Colorado State University, Fort Collins, Colorado
S. H. Kunkle and J. R. Meiman
Colorado State University Hydrology Paper No. 28, 27 p., March, 1968, 25 fig.,14 tabs., 13 ref.

Descriptors: *Sampling, *Bacteria, *Indicators, *Water pollution, *Waste, *Coliforms, *Streptococcus, *Bioindicators, Water pollution sources, Hydrographs, Statistical methods, Temperature, Cattle, Land use
Identifiers: *Water pollution indicators, Insolation, Parameters measured, Graphical plots, Variation coefficients

Pollution-indicating bacteria groups — the coliforms, fecal coliforms, and fecal streptococci —were used to investigate bacteria fluctuations and concentrations below and above a pollution source in a small high-elevation stream in the Colorado Rocky Mountains, 1966-67. The upper of 2 sites sampled was streamflow from an uninhabited forested area, while the lower (1.5 mi. downstream) was below a grazed meadow irrigated by the creek. Statistical analysis showed that analytical error is an important source of variation with a coefficient of 0.5 in coliform replicates from one bottle, that there was more day-to-day variation than within a day, and that variability was highest at lowest concentrations. Bacteria counts showed a daily cycle with highest counts in the evening, lowest in the afternoon, and intermediate morning values. Seasonally, the spring high stage had the highest counts at the lower site while counts were highest at low flows at the upper site. The cattle-influenced site always had higher counts than the upper site. Water temperature was inversely related to concentration. Insolation rapidly killed bacteria. Coliform to streptococci ratio was less than 1.0 at the upper site and ranged from 1.70 to 5.45 at the lower. (Kunkle, Meiman-Colorado State University)

2221 - A2, B1, E2 200

### WASTE CONTROL ALTERNATIVES

Agricultural Engineer, U. S. Department of Agriculture, Nebraska University
C. B. Gilbertson
Proceedings, Pollution Research Symposium, Lincoln, Nebraska, May 23, 1969, p. 50-57.

Descriptors: *Agricultural runoff, *Feedlots, Lagoons, Topography, Climates, Housing, Design
Identifiers: *Waste management, Detention pond, Land disposal

Conventional outdoor feedlots are confronted with two basic problems. One is the handling of solids on the feedlot surface, and the other is the control of runoff. Waste control alternatives for solids handling are: (1) remove manure after each cattle cycle, (2) intermittent cleaning of critical areas, and (3) stockpile manure. Control design of a facility and management scheme must fit existing enterprises and consist of an area to detain solids and a pond to detain the liquid. Individual design based on information from a topographic map of the feedlot area, management alternatives for runoff disposal, such as irrigation, land disposal or direct release into the environment must be completed. In the production of beef, several alternatives must be considered: (1) conventional outdoor, unsurfaced lots on slopes up to 10 percent; (2) surfaced outdoor lots, "cold housed" and "hot housed" confinement. Specific conditions coupled with the feedlot operator's judgement will determine the type of operation he will have. (Batties-East Central)

2222 - B2, E2 100

### COMPARATIVE CHANGES IN SOIL-PHYSICAL PROPERTIES INDUCED BY ADMIXTURES OF MANURES FROM VARIOUS DOMESTIC ANIMALS

California University, Davis
A. A. R. Hafez
Soil Science, Vol. 118, No. 1, p. 53-59, July, 1974. 1 fig., 7 tab., 9 ref.

Descriptors: *Soils, *Physical properties, Cattle, Poultry, Hydraulic conductivity
Identifiers: *Manure, Horses, Water holding capacity, Compactibility, Modulus of rupture

The objective of this study was to compare, by laboratory tests, the physical properties of soils as they are altered by animal manures which in themselves have different physical properties. Organic matter improves the tillage properties of soil and alters soil structure favorably by reducing bulk density. In this experiment, each kind of animal manure progressively decreased soil bulk density as the rates of applied manure increased. Increases in water-holding capacity were definitely induced by manure additions to soil and the increases were functions both of the quantity and type of manure added. There was a pronounced hydraulic conductivity improvement factor present in beef cattle and horse manures but very little in the chicken manure application. Manure applications at a rate of 5 percent favorably increased the soil shrinkage limit. Addition of animal manure to clay soil decreased compactibility. Also, dairy and beef cattle manures were more effective than chicken manure in decreasing the bulk density of compacted soil, whether at low or high soil-water contents. The soil strength as indicated by the modulus of rupture when different types and rates of animal manures were mixed with clay were reduced. The fibrous materials in manures play a major role in altering physical properties of soils. (Cartmell-East Central)

2223 - D2, F1 100

### COMPARISON OF THE CONVENTIONAL CAGE ROTOR AND JET-AERO-MIX SYSTEMS IN OXIDATION DITCH OPERATIONS

Department of Agricultural Engineering, Cornell University, Ithaca, New York
G. M. Wong-Chong, A. C. Anthonisen, and R. C. Loehr
Water Research, Vol. 8, p. 761-768, 1974. 6 fig., 6 tab., 6 ref.

Descriptors: *Aeration, *Liquid wastes, Odor, Costs
Identifiers: *Oxidation ditch, *JAM system, *Cage rotor system

This report discusses an alternative to a cage rotor for an oxidation ditch and compares the performance of two aeration systems when used for the treatment of high strength wastes. The alternative to the cage rotor is the JAM system which achieves both mixing and aeration by pumping the mixed liquid through nozzles. Mixing is maintained by energy and momentum transfer from jet streams to the bulk liquid and the concomitant turbulence and aspirator capacity of the jet streams bring about the aeration. In a comparison of the oxygen transferability of both JAM and cage rotor systems, the two systems are reasonably comparable for the conditions tested. Because of this equality, the operating costs from an energy consumption standpoint are also about equal. From a general maintenance performance the JAM system does not have the bearings and drive belt slippage problems associated with the cage rotor. From an odor and general nuisance standpoint, the aerobic treatment unit in the enclosed controlled environment alleviated problems which occurred in the previous open-sided housing system. (Cartmell-East Central)

2224 - B2, E2 400

### DAIRY WASTE GOES FULL CYCLE IN RESEARCH

T. B. Pratt
Sunshine State Agricultural Research Report, Vol. 17, p. 10-11, July-August, 1972. 7 fig.

Descriptors: *Dairy industry, Liquid wastes, Irrigation, Nutrients, Salts, Soil profile
Identifiers: *Land disposal

Studies on the feasibility of spraying dairy wastes over the land, including uptake of the nutrients by soil and water, yield of different crops, and movement of nutrients and salts in the soil are in their third year at Hague, Florida. (Whetstone, Parker, & Wells-Texas Tech University)

2225 - B2, C5, D2 700

### AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF BAFFLES ON THE AGITATION AND REMOVAL OF MANURE SOLIDS FROM A LIQUID MANURE HOLDING TANK

F. B. Scholfield, Jr.
Unpublished MS Thesis, Department of Agricultural Engineering, University of Tennessee, Knoxville, 1969, 35 p. 11 fig., 1 tab.

Descriptors: *Baffles, *Solid wastes, *Liquid wastes, *Model studies, Cattle, Moisture, Viscosity
Identifiers: *Agitation, *Removal, *Manure, *Holding tank, *Peat moss

Laboratory models constructed to one-fifth scale of a prototype liquid manure system were investigated in order to study the effects of internal obstructions in a model manure holding tank. The agitation nozzle, baffles, and pumping rates were also modeled. Peat moss was used to simulate scaled cow manure. The tests were run with four different baffle arrangements: (1) no baffles, (2) center baffles, (3) side baffles, and (4) side and center baffles. The following conclusions were drawn: (1) the use of the three baffle arrangements decreased the amount of solids left in the tank, and (2) the geometric placement of the agitator nozzle in this study and the use of baffles had a favorable effect on slurry agitation. Based on the volume of solids buildup above a slurry base level of 1.5 inches, these tests showed that a significant difference in the removal of settled solids existed between each of the four treatments. (Cameron-East Central)

2226 - B1, C3 100

### INFLUENCE OF LOW LEVEL HANDLING STRESS ON NITROGEN EXCRETION OF BLUEGILL SUNFISH (LEPOMIS MACHROCHIRUS RAFINESQUE)

Biology Department, Loyola University of Chicago, Illinois
J. Savitz
Transactions of the American Fisheries Society, Vol. 102, No. 3, p. 629-630, July, 1973. 1 fig., 9 ref.

Descriptors: *Stress, *Nitrogen, *Fish behavior
Identifiers: *Excretion, *Bluegill Sunfish

The study was designed to test whether minimal handling, as would occur in laboratory investigations of fish metabolism, would affect nitrogen excretion of bluegill sunfish. The study was carried out using bluegills weighing 33.9+/—1.4g (x+/—SE which were starved for one week prior to experimentation. Handling consisted of catching a fish with a dip net and placing it in a bucket of water for approximately 1 minute. Then it was caught by hand, weighed and placed in 8 liters of water in an individual covered aerated aquarium. Total nitrogen analysis of water samples from the aquariums revealed that the handling stress was not severe enough to cause significant changes in mean nitrogen excretion rates. However, Fromm and Gillette (1968) showed that nitrogen excretion rates of goldfish can be influenced by ammonia already in the water. (Kehl-East Central)

2227 - A1, B2, E2, F1 700

### DESIGN FOR BENEFICIAL USE OF FEEDLOT RUNOFF

L. R. Shuyler
MS Thesis, Department of Agricultural Engineering, Kansas State University, 1969, 59 p. 9 fig., 10 tab., 16 ref.

Descriptors: *Design, Agricultural runoff, *Feedlots, Costs, Rainfall, Irrigation

The purpose of this report was to investigate one method of disposal of liquid waste from a feedlot operation. It dealt with only the disposal of the liquid waste generated in the form of runoff caused by rainfall. It was concluded that from an engineering standpoint, the disposal of waste water from feedlot drainage areas can be accomplished by using it for irrigation water on agricultural land, where land area permits. It appears safe to assume that groundwater pollution can be avoided if, in the application of waste water, no more nutrients, on the average, are added to the soil than can be removed with the cropping program. The cost of this type of disposal system is quite small when expressed on a per animal basis, considering the total annual capacity of the feedlot. (Cartmell-East Central)

2228 - A2 700

### ANNUAL TOTALS AND TEMPORAL DISTRIBUTION OF CATTLE FEEDLOT RUNOFF IN KANSAS

Agricultural Engineering Department, Minnesota University
F. G. Bergsrud
Master's Report, Agricultural Engineering Department, Kansas State University, 1967, 106 p. 41 fig., 3 tab., 21 ref.

Descriptors: *Agricultural runoff, *Feedlots, *Cattle, Precipitation (atmospheric), Computers, Kansas
Identifiers: *Annual totals *Temporal distribution, Watershed factors, Hydrologic soil cover complexes

The objectives of this study were: to establish a system for determining the total annual runoff, the inflow rates, and the temporal distribution of runoff from cattle feedlots; to analyze data using this system; and to examine the data to determine the range and distribution of occurrances using the system. The factors affecting runoff were precipitation factors and watershed factors. Data from twelve stations in Kansas were analyzed by computer for a period of thirty years. A summary of data described in the station data section is given. It was concluded that a computer can be successfully used with weather tapes to obtain runoff data from feedlots. The analyses of this data may prove beneficial in the design of runoff retention or storage structures. (Cartmell-East Central)

2229 - A1, E2 700

### DEVELOPMENT OF A NITROGEN BALANCE IN A LABORATORY SOIL PROFILE WITH A HEAVY APPLICATION OF BEEF CATTLE WASTES

J. A. George
MS Thesis, Department of Agricultural Engineering, Kansas State University, 1970, 136 p. 6 fig., 10 tab., 8 ref.

Descriptors: *Animal wastes, *Cattle, *Soil profile, Feedlots, Denitrification, Sampling, Analysis
Identifiers: *Nitrogen balance

The purpose of this project was to study the nitrogen cycle as it occurs in a soil profile with a high loading rate of beef feedlot wastes. In order to study denitrification under as natural conditions as possible and in order to determine a total nitrogen balance, an apparatus which combined the total soil profile of a lysimeter, the closed gas collection system of an incubation apparatus and the soil solution sampling ability of a soil percolation apparatus was designed. The results of 13 test runs revealed few solid facts about denitrification. They did indicate that part of the apparatus had great potential and that other parts needed further development and experimentation. The gas measuring and analysis part of the unit did not produce usable data, but the water sampling produced quite good data. The soil and manure analysis data indicated that a considerable loss of nitrogen from the soil column occurred. Less than 10 percent of the total nitrogen lost from the soil was leached out in the water samples, indicating that the drawing off of water samples removes a minimum of nitrogen from the sight of active transformations. Only 2 percent of the total indicated nitrogen loss was leached out of the bottom of the 4 foot soil profile. (Cartmell-East Central)

2230 - E2, F1 400

### MANURE DECREASES NEED FOR FERTILIZER

Wallaces Farmer, Vol. 97, p 6, March 25, 1972.

Descriptors: *Fertilizers, *Nutrients
Identifiers: *Manure, *Tilth, *Croplands, Bedding

Under proper management, manure application to croplands provides valuable nutrients and increases soil tilth and water holding capacity. Relative values of different manures range from $2 per ton for dairy cattle to over $6 per ton for poultry. A 1000 pound beef animal will produce 10.95 tons of wet manure per year at 85% moisture. Bedding should be added in sufficient amounts to absorb the liquid and thus reduce handling difficulties. Straw, cornstalk, soft wood shavings, sawdust and peatmoss all absorb many times their weight in moisture and thus retain valuable nutrients such as nitrogen, phosphorus, and potassium. (Battles-East Central)

2231 - B1, C3, E2 400

### MANURE CAN CUT YOUR FERTILIZER BILL

W. Groves
Wallaces Farmer, Vol. 97, No. 19, p. 40-41, October 14, 1972. 2 tab.

Descriptors: *Fertilizers, *Costs, *Nutrients, Nitrogen, Phosphorus, Potassium, Irrigation, Lagoons
Identifiers: *Land spreading, Oxidation ditch

A well-managed manure handling system can help trim chemical fertilizer costs. Experiments were conducted on 6 types of waste handling systems by Dale Vanderholm, Iowa State University extension agricultural engineer. The systems tested included: (1) combination oxidation ditch and anaerobic lagoon with irrigation or liquid spreading, (2) deep pit storage with liquid spreading, (3) anaerobic lagoon with liquid spreading or irrigation, (4) aerobic lagoon with irrigation or liquid spreading, (5) bedded confinement with solid spreading, (6) open lot with or without shelter; solid spreading with runoff collected and irrigated or liquid spread. System 1 showed the greatest loss of nitrogen and system 5 showed the least loss of all systems tested. At 7 cents per pound, anywhere from $5.25 to $12.95 worth of nitrogen may be lost from a 1000 lb. beef animal's excrement, depending upon the system. Vanderholm figures a 50% $P_2O_3$ loss and a 30% $K_2O$ loss in anaerobic lagoons, but no losses in other systems. Use of Vanderholm's guidelines can be of help in determining how much land is needed in spreading various types of manure. (Battles-East Central)

2232 - A1, B1, F2 400

### EPA AND THE FISH FARMER

Chairman, CFA Research Committee and the 12-State S-83 Catfish Research Committee
J. W. Avault, Jr.
The Catfish Farmer, Vol. 6, No. 4, p. 16-17, 30, July/August, 1974.

Descriptors: *Fish farming, *Regulations, *Effluent, Ponds, Suspended solids, Pollutants, Monitoring
Identifiers: *Environmental Protection Agency, Raceways, Settleable solids, Fecal coliforms

The Environmental Protection Agency held a hearing on May 23, 1974, at Athens, Georgia, to discuss proposed regulations for the effluent of ponds, raceways, and other culture systems and drafted them into a 237-page book. Fish growers are divided into three categories: (1) Native fish — flow thru culturing systems, (2) Native fish — pond culturing, and (3) Non-native fish culturing system. The proposed regulations for category 1 call for the monitoring of suspended solids, settleable solids, NH(3)—N and net concentrations of fecal coliform bacteria. Limits are placed upon each of these four items. Proposals for category 2, where most catfish farmers would fit, demands that settleable solids must not exceed 3.3 milligrams per liter and fecal coliform must not exceed 200 organisms/100 ml. The proposed regulations for category 3 calls for no discharge of process wastewater pollutants. All these regulations are concerned solely with the quality of the water as it leaves the drain pipe. Proposed regulations must be implemented by July 1, 1977, and stricter regulations must be implemented by July 1, 1983. If these proposed regulations become law on October 25, 1974, the costs of periodically checking the wastewaters and cleaning up polluted water will be borne by the farmer. The EPA breaks its suggestions for methods of cleaning up catfish ponds into: (1) water conservation; (2) feeding practices; (3) fish distribution; (4) pond draining; and (5) harvesting. (Battles-East Central)

2233 - C1, D4 700

### CHARACTERISTICS AND ANAEROBIC DIGESTION OF SWINE WASTE

Spillman, C. K.
M. S. Thesis, University of Illinois, Department of Agricultural Engineering, 1963, 54 p.

Descriptors: *Farm wastes, *Hogs, *Anaerobic digestion, *Waste treatment, *Waste storage, *Waste disposal, Gases, Confinement pens, Effluent, Nitrogen, Chemical oxygen demand, Biochemical oxygen demand, Hydrogen ion concentration
Identifiers: *Swine, Loading rates, Ammonia nitrogen, Organic nitrogen, slotted floors

The objectives of this study were: (1) to study the breakdown of organic matter which occurs when swine waste is stored under slotted floors and allowed to decompose anaerobically, and (2) to determine some characteristics of swine waste which are important in the design of disposal systems. To accomplish these objectives, 12 digesters were set up and loaded with swine waste material at rates considered typical of those in use in slotted floor hog houses. The characteristics of swine waste could be determined from the results obtained from the tests on waste material. Tests were run for ammonia nitrogen, organic nitrogen, chemical oxygen demand, and biochemical oxygen demand. A design recommendation was to make the pits under slotted floors 3 to 5 feet deep. The most important aspect of pits under slotted floors is the effect on the animals of the gases produced during digestion. The gases produced and the concentration which would exist in buildings should be determined. (Cartmell-East Central)

2234 - B1, C1, D4 700

### AEROBIC DIGESTION OF CATTLE WASTE

Jones, D. D.
MS Thesis, Agricultural Engineering Department, Illinois University, 1967, 127 p., 38 fig., 9 tab., 21 ref.

Descriptors: *Farm wastes, *Cattle, *Waste treatment, Chemical oxygen demand, Biochemical oxygen demand, Diets, Digestion, Dairy industry, Analysis, Nitrogen, Potassium, Phosphours
Identifiers: *Aerobic digestion, *Loading rates, Volatile solids, Fixed solids.

This study was undertaken to determine the effectiveness of the aerobic digestion process in the treatment of dairy and beef cattle wastes. Wastes were collected from livestock being fed high concentrate ration. It was added in varying loading rates to laboratory aerobic digesters. For dairy cattle, a waste feed having a BOD concentration of 19,400mg/1 and a VS concentration of 50,000 mg/1 was added to digesters. Total BOD reductions of 70, 60, and 76 percent and total VS reductions of 20, 15, and 0 percent, respectively, were obtained for the loading rates of 125, 150, and 200 ml. Because of the extremely large amount of nonbiodegradable organic matter present, all three digesters may have been overloaded. Due to the settling of solids during the latter part of the feed period, no conclusions can be drawn as to the effectiveness of treatment of the optimum of loading rate. For beef cattle, a waste feed having a BOD concentration of 8,000 mg/1 and a VS concentration of 30,000 mg/1 was added to digesters. Total BOD reductions of 59, 70, and 40 percent and total VS reductions of 38, 27, and 16 percent, respectively, were obtained for the loading rates of 100, 150, and 200 ml. Optimum loading rate was determined to be 150 ml. and significant reduction of biodegradable organic concentrations was obtained. (Cartmell-East Central)

2235 - A1, B1, D1, E2 100

### FATE OF NITROGEN UNDER INTENSIVE ANIMAL FEEDING

Agricultural Research Service, United States Department of Agriculture, Fort Collins, Colorado
F. G. Viets
FEDERATION PROCEEDINGS, Vol. 33, No. 5, p. 1178-1182, May, 1972. 24 ref.

Descriptors: *Nitrogen compounds, *Feedlots, Denitrification, Agricultural runoff, Ammonia
Identifiers: *Pollution, Land disposal, Amines

Among the potential nitrogenous pollutants arising from the feeding of protein and urea are microbial protein, amino acids, urea, uric acid, ammonia, and a host of complex compounds that either have not been identified or have been ignored. The amount of nitrogen available for beneficial use on growing crops depends on management and waste collection. The pathways for removing this nitrogen are manure hauling, runoff, percolation, denitrification on site, and volatilizaiton of ammonia and other basic N compounds. The source of nitrate in a shallow farm well has been considered to be drainage from septic tanks, cesspools, and barnyards, with overfertilization of crops being an insignificant contributor except on very sandy soils. Ammonia is a contaminant of all air and rain. The feedlot, as a source of ammonia, represents a great disturbance of the environment. Amines are of concern for two reasons. They are very stinky substances that are persistent in sticking to clothing and most all kinds of surfaces. Second, the secondary amines can combine with nitrite under favorable conditions to produce the highly carcinogenic, teratogenic, and mutagenic nitrosamines. (Cartmell-East Central)

2236 - A1, E2 100

### USING POULTRY MANURE COMPOST TO RECLAIM SALT POLLUTED SOILS

Assistant Agronomist, Department of Agronomy, Arkansas University, Fayetteville 72701
L. H. Hileman
Compost Science, Vol. 15, No. 2, p. 22-23, March-April, 1974. 2 fig., 2 tab.

Descriptors: *Reclamation, *Poultry, *Grasses, Phosphorus, Calcium, Potassium, Magnesium, Conductivity
Identifiers: *Salt polluted soils, *Compost, *Excreta, pH

Brine water dumping from oil field operations, which was permitted in the past, resulted in barren land of little or no value. In 1970, Dr. H. C. Dean, State Soil Scientist, surveyed the problem in southern Arkansas. In 1971, a compost made with chicken manure was applied to a brine-polluted area to see if it would be useful in reclaiming the land. The compost was applied at a rate of 6 tons per acre and rototilled into the upper 4 inches of the soil. The land was then seeded with Japanese millet, Pangburn switchgrass, bahia, common bermuda grass, and Kobe lespedeza. The treated area was overseeded in the fall of 1971 with Kentucky-31 fescue and crimson clover. All species germinated and grew; however, the lespedeza and clover did not grow over about 3 months. The grasses survived well and grew for three years without further treatment. Tests revealed that the compost application improved soil pH, phosphorus, calcium, and sodium. There was very little change in potassium, magnesium, and conductivity. It is thus indicated that a good quality compost can be used to reclaim brine polluted land. Further experimentation is needed to determine required rates of compost. (Merryman-East Central)

2237 - A5, A9, B1, D4 400

### COMPOSTING POULTRY MANURE IN DEEP-PITS

Extension Poultry Products Specialist, Purdue University, Lafayette, Indiana
J. G. Berry
Feedstuffs, Vol. 43, p. 32, July 3, 1971.

Descriptors: *Composting, *Poultry, *Waste storage, Odor, Rodents, Costs
Identifiers: *Deep-pit, Flies

Deep pits in operation up to six years without odors, flies, or troubles are reported. The overriding consideration is that the manure must be kept dry. Sealing of the pit to protect groundwater and to exclude rodents is desirable. Labor and operating costs can be reduced significantly by use of deep pits. Building costs will be higher and serious trouble may occur if the manure gets wet. (Whetstone, Parker, & Wells-Texas Tech University)

2238 - A5, B1, D2 400

### TWO-STAGE DRYING FOR MANURE DISPOSAL ADVOCATED BY PENN STATE POULTRYMAN

Feedstuffs Staff Writer
G. Lauser
Feedstuffs, Vol. 34, p. 7, 33, July 31, 1971.

Descriptors: *Drying, *Poultry, *Economics, Odor, Aeration
Identifiers: *Deep-pit storage, Refeeding, Land disposal

Glenn Bressler considers the deep pit to be the worst possible "solution" to poultry manure disposal. When the day of cleanout finally arrives, the sticky, odiferous mess will have lost its fertilizer value. Liquid handling pollutes large volumes of water with resulting higher costs for low-pollution disposal. Two-stage drying, with the first stage occurring in place and reducing the moisture content from 75 percent to 35 percent, is advocated. Cost data are cited. (Whetstone, Parker, & Wells-Texas Tech University)

2239 - E3 400

### ARIZONA FEEDS HELPING IN BEEF WASTE RECLAMATION

Feedstuffs, Vol. 44, p. 5, March 6, 1972.

Descriptors: *Arizona, *Cattle, *Feeds, *Proteins
Identifiers: *Refeeding, *Waste reclamation

Arizona Feeds of Tucson is cooperating with General Electric in a project for the production of 120 lb. per day of protein for cattle feed. The source is cattle manure. (Whetstone, Parker, and Wells, Texas Tech University)

2240 - E3 400

### GENERAL ELECTRIC TO RECYCLE BEEF MANURE INTO PROTEIN FEED AT NEW ARIZONA PLANT

Feedstuffs, Vol. 44, p. 4, April 10, 1972. 1 fig.

Descriptors: *Feeds, *Cattle, *Arizona, Thermophilic bacteria, Proteins
Identifiers: *General Electric, *Refeeding

A pilot plant at Casa Grande, Arizona, scheduled to begin production in the summer of 1972 will process the wastes from 100 cattle by providing for digestion of the waste by thermophilic bacteria followed by harvesting of the bacteria for protein. Years of research have gone into the process wherein 400 500 lb. manure (dry weight) will produce 120-150 lb. protein. Other cellulose wastes would be amenable to the same process. (Whetstone, Parker, & Wells-Texas Tech University)

2241 - A1, B2. E2 100

### THE PERFORMANCE OF AN EXPERIMENTAL HIGH-RATE BIOLOGICAL FILTRATION TOWER WHEN TREATING A PIGGERY SLURRY

Farm Buildings and Information Division, National Institute of Agricultural Engineering, England
R. Q. Hepherd and A. H. Charlock

Descriptors: *Filtration, *Slurries, *Dewatering, Design, Suspended solids
Identifiers: *Swine, *High rate biological filtration

Waste disposal problems are being caused on many farms by the intensification of livestock enterprises and the development of housing systems in which little or no bedding material is used. Also, the discharge of slurries or other liquid from wastes into ditches, streams, rivers, etc., or (exceptionally) even on to land, without the prior approval of the authority concerned is prohibited by such Acts as the Rivers (Prevention of Pollution) Acts of 1951 and 1971, and the Water Resources Act of 1963. The objectives of this study were: (1) to provide engineering data for the design of a farm-scale experimental plant, which would allow the various aspects of the process to be examined in greater depth and (2) to investigate the performance of plastics and other lightweight filter media. Present knowledge suggests that the high-rate biofiltration type of anaerobic treatment may be an economical alternative to conventional methods of disposing of pig wastes to land. The study showed that sludge dewatering by filtration through straw may be practicable for the smaller piggery units. However, for the larger pig units and for plants treating cattle slurries, the development of mechanical dewatering equipment appears to be essential. The difficulty of controlling the solids level at dry matter loadings over about 27 kg/d was the cause for the limitation to the loading of the pilot plant. Effluent quality was normally between 300 and 800 mg/1 suspended solids and 100 and 300 mg/1 BOD and the daily volume was small (about 0.9m(3), neglecting evaporating losses, etc., which were not measured). A new and larger pilot-scale plant is presently being constructed to study in greater detail the effects of higher loading rates on plant performance, on sludge dewatering, on the incidence of blockage in various medium types, and on low-cost equipment for effluent-land application. (Kehl-East Central)

2242 - A6, C1 100

### NITROGEN LOSS FROM MANURE AS INFLUENCED BY MOISTURE AND TEMPERATURE

Department of Soil Science, Michigan State University, East Lansing
D. C. Adriano, A. C. Chang, and R. Sharpless
Journal of Environmental Quality, Vol. 3, p. 258-261, July-September, 1974. 1 fig., 4 tab., 22 ref.

Descriptors: *Nitrogen, *Moisture, *Temperature, *Soil, *Feedlots, Nitrification
Identifiers: *Volatilization

One of the principal components in cattle wastes that requires critical attention because of its impact on environmental quality is nitrogen. The main objective of this study was to evaluate under controlled conditions, the effect of the interactions of soil temperatures with moisture on manurial N loss. These two variables' effects no N losses from different application rates of manure were studied under greenhuose conditions at two soil temperatures (10° and 25° C) and at two soil moistures (60 and 90% of water saturation percentage, WSP). There was no significant effect on the percentage of loss applied N by manurial rate. At 10° C, the average losses of applied N for the 60 and 90% moisture levels were 26 and 39% respectively. At 25° F, higher losses for the 60 and 90% levels were 40 and 45%, respectively. It is felt that about 50% of the N from cattle manure applied to uncropped land can be lost within a few weeks through gaseous evolution largely as $NH_3$. In confined operations with paved lots or in old unpaved lots perhaps losses would even be higher. Ammonia absorption by clay minerals will be non-existent or minimal under these conditions. (Kehl-East Central)

2243 - A1, B1, E2 300

### CONFINEMENT LIVESTOCK FACILITIES WASTE MANAGEMENT CODE OF PRACTICE

Published under the authority of the Minister of the Environment and the Minister of Agriculture, Queen's Printer, September, 1973, 31 p. 7 fig., 4 tab.

Descriptors: *Canada, Alberta, Confinement pens, *Farm management, *Design, Odor, Livestock
Identifiers: *Isolation distances, Waste handling, Land application

Public concern about all forms of pollution of our environment is growing while intensive livestock operations are increasing in number and size. The number of residential dwellings on or near farmland is increasing. Developers of non-agricultural activities in agricultural areas should be aware that complete odor control is beyond present technical capabilities. These guidelines stress that when conflicts result from encroachment on agricultural areas, much of the responsibility should be accepted by the developers and not only the agricultural operator. Guidelines for confinement livestock facilities waste management intend to provide a technical base upon which livestock operators can develop without causing undue environmental impact. Administration and definitions regarding the guidelines are given. The guidelines are defined in terms of developments requiring compliance and the isolation distances. The various components of design guidelines for livestock facilities are listed and examined. The components include manure storage, earthen catch basins (and alternate methods), walled storage, storage lagoons and mechanically aerated systems. The guidelines for animal waste management, including the handling of solid and liquid manure, are discussed. Land application is also examined. Directions for the procedure for using the code are given. (Kehl-East Central)

2244 - A9, D1, E3 100

### EFFECT OF PROCESSING METHOD ON PASTURIZATION AND NITROGEN COMPONENTS OF BROILER LITTER AND ON NITROGEN UTILIZATION BY SHEEP

Virginia Polytechnic Institute and State University, Blacksburg 24061
L. F. Caswell, J. P. Fontenot, and K. E. Webb, Jr.
Journal of Animal Science, Vol. 40, No. 4, p. 750-759, April, 1975. 3 tab., 33 ref.

Identifiers: *Sheep, *Broiler litter, *Refeeding, *Pasturization, *Nitrogen utilization, Processing method

Experiments were conducted to determine the effect of different methods of processing broiler litter on pasturization and nitrogen components of litter, and to study the relative effects on nitrogen utilization, ration digestibility and blood and ruminal parameters when litter was fed to sheep. It was concluded that methods found to be effective pasteurization processes were: Dry heating at 150° C for 20 min., autoclaving for 10 min., dry heating at 150° C at depths of .6 or 2.5 cm with addition of paraformaldehyde, and ethylene oxide fumigation for a minimum of 30 minutes. No digestive disturbances were observed in the experimental animals. Fecal, urinary and total nitrogen excretion did not differ among treatments. Processing method did not affect the apparent digestibility of dry matter, crude protein, ether extract, crude fiber and NFE. Blood urea levels were not significantly different among treatments. Acetic acid was significantly higher for the animals fed dry heat plus PFA treated litter than for either of the other treatment groups. (Cartmell-East Central)

2245 - A4, E2 600

### GROUNDWATER QUALITY BENEATH A MANURE DISPOSAL AREA

Agricultural Engineering Department, Texas A&M University
D. L. Reddell
Presented at the 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, 15 p. 11 tab., 15 ref.

Descriptors: *Waste disposal, *Nutrients, Nitrogen, Sodium, Chloride, Ammonium, Chemical oxygen demand
Identifiers: *Groundwater quality, *Land disposal

The objective of this research was to evaluate the effect of a very heavy application of beef manure on the groundwater quality of a manure disposal area at El Paso, Texas. It was concluded that groundwater showed increased amounts of chloride, COD, ammonium, sodium, organic-N and nitrate for a period of approximately 1 year following the manure application, but then decreased to background levels in most cases within 2 years after the application. Also, nitrates accumulated in the unsaturated soil zone above the water table during much of this study. However, they apparently denitrified upon entering the water table, because groundwater samples indicated only minor increases in $NO_3$ levels. (Cartmell-East Central)

2246 - B1, F2 600

### IMPACT OF ENVIRONMENTAL REGULATION ON THE LIVESTOCK INDUSTRY

Executive Vice President, National Livestock Feeders Association, Omaha, Nebraska
B. H. Jones
Presented at 1973 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-14, 1973, 9 p.

Descriptors: *Regulation, *Feedlots, *Costs, Livestock

A discussion of proposed guidelines and the effect they could have on the stability of rural economics, production costs, supplies of animal products, and consumer prices is given. In terms of price increases and overall industry capacity, the economic impact of the proposed effluent guidelines for feedlots would not be serious. Agriculture and business and industry have been receiving eroding blows for a period of years, but the impact of environmental regulation will fall mostly on the small operator. It is said that many of these will be forced out of business. The industry may be pushed toward the middle of the road in terms of the unit size of operation. It is important to consider that environmental control expenditure does not generate additional cash flow or new income opportunitities. Such investments are not cost-reducing or production-increasing. In fact, they are cost-creating, since they give rise to additional maintenance and other operational costs. (Cartmell-East Central)

2247 - A5, B1, C3 400

### ANIMAL WASTE DISPOSAL METHODS—PRESENT AND FUTURE

E. P. Taiganides
Feedstuffs, Vol. 40, No. 37, p. 37-38, September 14, 1968. 3 tab.

Descriptors: *Animal wastes, Waste disposal, *Odor, Gases
Identifiers: *Waste management

The factors that cause or aggravate the animal producers' waste disposal problems may be grouped as follows. 1. Manure characteristics. 2. Present methods of manure handling and disposal. 3. Expansion of urban centers into rural areas plus public awareness of the need for a healthy and aesthetically pleasant atmosphere. Control of odor and odorous gases is a vexing problem for the feedlot owner. The most important gases generated within an animal confinement unit are carbon dioxide, ammonia, hydrogen sulfide, methane, and trace quantities of a host of organic compounds such as acids, mercaptans, skatols, etc. The largest single problem associated with confinement units involves manure management. Of the present methods of manure handling, the most important are anaerobic lagoons, digesters, aerobic oxidation, dehydration, coprophagy, composting, and land spreading. (Cartmell-East Central)

2248 - C3 300

### IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUREMENT OF AMMONIA EVOLUTION RATES FROM MANURE-COVERED SURFACES

Department of Agricultural Engineering, Oregon State University, Corvallis, Oregon 97331
J. R. Miner, M. D. Kelly and A. W. Anderson
Technical Paper No. 3972, Oregon Agricultural Experiment Station, 1974, 11 p. 2 fig., 3 tab., 6 ref.

Descriptors: *Organic compounds, *Measurement, *Ammonia, Nitrogen, Lagoons
Identifiers: *Swine building, *Manure - covered surfaces, *Identification

In an effort to devise a field technique for sampling and measuring airborne volatile organic compounds in the vicinity of livestock production facilities, a trapping procedure was developed. A sampling box was designed and built which permitted the measurement of ammonia generation rates from earth, building, and treatment system surfaces. These measurements qualified the rate of ammonia release from dairy and swine housing areas, manure storage facilities, and grassland used for manure disposal. In addition to the ammonia evolution, these studies indicated a non-ammonia nitrogen evolution rate ranging from 0.25 to 0.75 of the ammonia. No correlation was evident from these data between age of manure and non-ammonia nitrogen ammonia release rates. Non-ammonia nitrogen values were consistently low from the swine manure lagoon surface. (Cartmell-East Central)

2249 - C3 100

### IDENTIFICATION OF ALIPHATIC AMINES VOLATILIZED FROM CATTLE FEEDYARD

U. S. Department of Agriculture, Agricultural Research Service, P. O. Box E, Fort Collins, Colorado 80521
A. R. Mosier, C. E. Andre, & F. G. Viets, Jr.
Environmental Science and Technology, Vol. 7, p. 642-644, 1973. 2 fig., 3 tab., 11 ref.

Descriptors: *Feedlots, *Cattle, *Volatilization, Nitrogen compounds
Identifiers: *Aliphatic amines, *Identification, Dilute acid traps

An investigation was conducted to identify some of the basic organic N-containing compounds volatilized from a cattle feedlot. These compounds were collected in dilute acid traps. Direct gc analyses of the acid trap concentrates showed that 10 compounds could be observed. To identify these compounds the retention times of the unknown materials were compared with those of the standard aliphatic amines. Methyl, dimethyl, ethel, n-propyl, iso-propyl, n-butyl, and n-amylamines were among the basic N-compounds volatilizing from a high density cattle feedyard. (Cartmell-East Central)

2250 - A1, C3 100

### CHEMICAL CHARACTERISTICS OF A FEEDLOT SOIL PROFILE

U. S. Department of Agriculture, Agricultural Research Service, Lincoln, Nebraska
G. E. Schuman & T. M. McCalla
Soil Science, Vol. 119, No. 2, p. 113-118, February, 1975. 6 fig., 2 ref.

Descriptors: **Feedlots, *Soil profiles, *Chemical properties, Nitrates, Potassium
Identifiers: *Impermeable layer

This study was made to determine the chemical composition of feedlot profiles, which might be helpful in understanding the characteristics of feedlot soil profile and the effects of the observed characteristics on the profile. The exchange complex was predominantly saturated with K in the top 15 cm of the soil profile immediately below the manure pack. Ca became the dominant ion below that depth. The high K resulted from large amounts of K in the rations fed to the livestock. The zone where high levels of K were present was also high in carbon. This zone was very dark and slightly more dense than the material above and below. The permeability of this dark layer was low. Soil columns leached with $CaCl_2$ allowed percolation to occur, which indicated that the sealing was at least partially due to the K. No percolate resulted from the distilled water of KC1 solution treatments. $NO_3$-N was very low below the impermeable layer and several fold higher in the field profile. (Cartmell - East Central)

2251 - A1, E2, E3 400

### FERTILIZER, FEED VALUE OF SWINE WASTES DETAILED

J. D. Kendall, Editor
Feedstuffs, Vol. 47, p. 12-13, April, 1975.

Descriptors: *Recycling, *Fertilizers, *Feeds
Identifiers: *Hogs, *Feces, *Refeeding, Application rates, Performance

A summary of a paper on the value of swine waste as a fertilizer and a feed resource is presented. The composition of manure can vary and change, due to the following three factors: (1) the nutrient composition and type of ration fed to the pigs; (2) the amount of feed and water wastage and the amount of bedding used with manure, and (3) waste handling and storage methods. Some factors to consider for efficient use of swine waste on land are: method of application, time of application, soil characteristics, and crop nutrient removal. Excessive nitrogen loading, salinity problems, and accumulation of heavy metals in the soil and growing crops are probably the greatest hazards for heavy and long-term applications of waste to the soil. Swine waste is a potential feed ingredient. In past research pig feces have made up as much as 15% of a ration without any adverse effect on feed efficiency. (Cartmell-East Central)

2252 - A1, E2 100

### FEEDLOT WASTE EFFECTS ON SOIL CONDITIONS AND WATER EVAPORATION

USDA Southwestern Great Plains Research Center, Bushland, Texas 79012
P. W. Unger and B. A. Stewart
Soil Science Society of America Proceedings, Vol. 38, p. 954-957, 1974. 2 fig., 1 tab., 14 ref.

Descriptors: *Feedlots, *Effects, Bulk density, Porosity, Organic Matter, Evaporation
Identifiers: *Land disposal, *Application rates, Soil water retention, Aggregation

The purpose of this study was to evaluate the effects of various feedlot waste (FLW) application rates on various soil conditions and on evaporation of water from the soil. Feedlot wastes applied at rates considered adequate to supply the nutrient requirements of plants had no significant effects on soil conditions. The effects on soil conditions were significant as FLW application rates increased. The reduced bulk density and water retention at high matric potentials of the plow layer of FLW-treated soil suggest that water from irrigation or precipitation should move more readily to greater depths in the soil where the water is less susceptible to losses by evaporation and hence conserved for subsequent plant use. An evaporation study in the laboratory with FLW treated soil revealed reduced evaporation with increased rates of FLW application. (Cartmell-East Central)

2253 - A6 100

### ELEMENTAL COMPOSITION OF PARTICULATES NEAR A BEEF CATTLE FEEDLOT

Department of Soils and Plant Nutrition, California University, Davis 95616
J. Azevedo, R. G. Flocchini, T. A. Cahill, P. R. Stout
Journal of Environmental Quality, Vol. 3, No. 2, p. 171-174, April-June, 1974. 3 fig., 1 ref.

Descriptors: *Dusts, *Feedlots, *Cattles
Identifiers: *Manure, *Composition, *Particulates

Dusts from manures should have characteristic elemental signatures reasonably distinct from those of dusts from surrounding soils. The flow of dust near animal corrals was examined objectively through use of alpha-excited X-rays and the origin of aerosols in the surrounding air was assessed. The contribution of large particulates from the feedlot to the atmosphere was restricted to the immediate vicinity of the corrals. The feedlot contributed very little to the concentration of intermediate-sized particles in the air, but did have some influence on the smallest-sized particles. The summation of analyzed elements in each size stage downwind to the feed mill did not exceed those upwind. Eight elements (Si, A1, P, S, C1, K, Ca, and Fe) were present in detectable quantities in the majority of the air samples taken in the vicinity of the feedlot. (Cartmell-East Central)

2254 - B2, D4 100

### THE ANAEROBIC DIGESTION OF WASTE FROM AN INTENSIVE PIG UNIT

Rowett Research Institute, Bucksburn, Aberdeen, AB2, 9SB
P. N. Hobson & B. G. Shaw
Water Research, Vol. 7, No. 3, p. 437-449, 1973. 1 fig., 13 tab., 14 ref.

Descriptors: *Anaerobic digestion, *Waste treatment
Identifiers: *Swine, *Loading rates

Anaerobic digestion was investigated as a primary treatment for very strong agricultural wastes, to reduce the solids and polluting properties and to improve the settling of the waste in order to give a supernatant liquid which, while not up to river board standards would be suitable for discharge to town sewers, for secondary aerobic or other treatment, or for recycling as animal house wash-water. Six experiments were run. Experiments 1 and 2 concerned batch digestion of waste. The experiments showed that a proper digestion, with the primary acidic and secondary methanogenic fermentations in balance, could not be developed by direct incubation of undiluted or almost undiluted, pig waste. Experiment 3 showed that a balanced digestion of piggery waste could be obtained using a seed of digesting sewage, but that loading rate in the early stages of the digestion could be a critical factor. Experiment 4 showed that a balanced digestion of piggery waste could be achieved without a seed if the initial loading rate was low enough to allow a methanogenic flora to develop before a high acid concentration was reached. Experiments 5 and 6 dealt with performance of initially seeded and unseeded digestions at different loading rates. These two experiments revealed that balanced digestion could be obtained by using, initially, low loading rates and allowing time for the build-up of a stable population of the correct bacteria. (Cartmell-East Central)

2255 - A1, A4, E1, E2 300

## ANIMAL WASTES AND FERTILIZERS AS POTENTIAL SOURCES OF NITRATE POLLUTION OF WATER

U. S. Department of Agriculture, Fort Collins, Colorado
F. G. Viets, Jr.
Reprint from Effects of Agricultural Production on Nitrates in Food and Water with Particular Reference to Isotope Studies, Vienna, International Atomic Energy Agency, 1974, p. 63-76, 1 tab., 32 ref.

Descriptors: *Water pollution, *Nitrates, *Animal wastes, *Fertilizers, Hydrology, Nitrification, Infiltration, Eutrophication, Agricultural runoff, Ammonia, Volitalization
Identifiers: Isotopic nitrogen

An updating and supplementing of the U. S. Department of Agriculture Handbook 413, "Factors Affecting the Accumulation of Nitrate in Soil, Water, and Plants" (Viets and Hageman, 1971) is provided. A change over from vegetable protein to animal protein in the human diet has resulted in the increased use of nitrogen fertilizer in the developed countries for the last 30 years. Stocking rate and the continuity of use of the feed-yard or holding area appear to be the factors upon which nitrate percolation to aquifers depend. Because of inhibited nitrification and infiltration, modern high-density cattle feed-yards have low nitrate flux. Eutrophication and nitrate accumulation may be contributed to by volatilization of ammonia and its absorption by surface water. Nitrate leakage occurs under highly productive cultivated land regardless of the nitrogen source. Fertilization management must hold this leakage to a tolerable concentration in relation to hydrology and use of underground water in the area. There is a need for better understanding of land productivity, nitrate leakage, and hydrology. Assistance in solving these problems may be obtained from isotopic nitrogen. (Kehl-East Central)

2256 - A6 100

## DIURNAL FLUCTUATION AND MOVEMENT OF ATMOSPHERIC AMMONIA AND RELATED GASES FROM DAIRIES

Western Region, Agricultural Research Service, U. S. Department of Agriculture, and the California Agricultural Experiment Station
R. E. Luebs, K. R. Davis, and A. E. Laag

Descriptors: *Ammonia, *Dairy industry, *Gases, *Air pollution, Odor
Identifiers: *Diurnal fluctuation

Ammonia has been known to be in the atmosphere for nearly 100 years. Recently, concern for environmental quality has increased interest in $NH_3$ as a potential air pollutant. It has recently been shown that the waste or manure from large concentrations of domestic animals is a significant local source of atmospheric $NH_3$. This study, consequently, had three objectives: (1) determination of the atmospheric concentrations of ammonia and related gases near dairy operations, (2) determination of the stability of these concentrations, and (3) determination of the effect of wind areal distribution and concentrations. Simultaneous 24-hour air sampling, 0.8 km upwind from the nearest cows in a large dairy area (145,000 cows) and 11.2 km upwind from the dairy area were taken. The samples indicated distillable N concentrations of 190 and 6u g/m (3) respectively. Readings were also taken during a 24-hour period of the distillable-N concentration of a downwind corral fence of an isolated 600-cow dairy. This information indicated significant N loss from dairy waste by $NH_3$ volatilization. Meteorological factors greatly affected atmospheric concentrations of distillable N, particularly temperature inversions in the atmosphere and wind, along with proximity to the waste. Winds averaging 9.3 km/hour transported distillable N 500 m from the isolated dairy at a height of about 1.2 m. (Kehl-East Central)

2257 - A1, B1, F2 300

## CURRENT LIVESTOCK POLLUTION REGULATIONS

L. Lubinus and F. Kerr
Cooperative Extension Service, South Dakota State University, Brookings, August, 1974, 5 p.

Descriptors: *Water pollution, *Permits, *Livestock
Identifiers: *Point source, Technical assistance, Feedlot effluent standards

Public-Law 92-500 amended the Federal Water Pollution Control Act and was enacted October 18, 1972. It prohibits the discharge of pollutants (including livestock wastes) into any stream, lake or river from a point source without a permit issued from one of two offices. These permits are issued by the Federal Environmental Protection Agency's (EPA) regional office in Denver, Colorado, or from the South Dakota Department of Environmental Protection (DEP). The term "point source" is defined in terms of large and small feeding facilities using the type and number of animals to define the size. The NPDES (National Pollution Discharge Elimination System) is in charge of the permit program at the national level. Instructions of how and where to apply for a permit are given. Feedlot effluent standards, cost-sharing programs and technical assistance are briefly discussed. (Kehl-East Central)

2258 - A1, B1, D4 100

## THE BACTERIAL POPULATION OF PIGGERY-WASTE ANAEROBIC DIGESTERS

Rowett Research Institute, Bucksburn, Aberdeen
P. N. Hobson and B. G. Shaw
Water Research, Vol. 8, p. 507-516, 1974, 1 tab., 31 ref.

Descriptors: *Anaerobic digestion, *Bacteria, Sludge, Methane
Identifiers: *Piggery wastes, *Bacterial population, Facultative bacteria

Previous studies of piggery waste have described the setting up and running of laboratory-scale fermentors digesting piggery waste. This study not only covered the practical details of obtaining good digestion, but observations were made on the flora of the digesters during the setting up of digestion and while a balanced digestion was proceeding. The study made a survey of anaerobic and facultatively anaerobic bacteria present in piggery waste, digesting piggery waste and domestic anaerobic sludge used in starting a piggery waste digester. An influence of the input waste was shown in that streptococci were the predominant bacteria in the digesting waste, replacing Enterobacter when a piggery waste digestion had been established from the latter material. All the bacteria concerned in degradation of the waste constituents were anaerobes. Methane production from $H_2/CO_2$ formate and butyrate could be detected in mixed culture from digester contents dilution, but the only methanogenic bacterium that could be isolated in pure culture was Methanobacterium formicicum, which uses $H_2/CO_2$ or formate only. (Kehl-East Central)

2259 - A9, B1 100

## BACTERIAL CONTAMINATION OF HATCHING EGGS AND CHICKS PRODUCED BY BROILER BREEDERS HOUSED IN LITTER-SLAT AND SLOPING FLOOR MANAGEMENT SYSTEMS

Poultry Science and Veterinary Science Departments, The Pennsylvania State University, University Park 16802
T. A. Carter, R. F. Gentry and G. O. Bressler

Descriptors: *Bacteria, *Poultry
Identifiers: *Hatching eggs, *Chicks, *Bacterial contamination, *Litter-slat system, *Sloping floor system

Previous studies have indicated that air and egg shell bacterial counts are lowered when Leghorns or broiler breeders are kept in wire-floored houses instead of litter-floored houses. The two main objectives of this study are concerned with the study of bacterial contamination. The primary objective was to determine if any differences existed in the type and amount of bacterial contamination in eggs and chicks produced by sloping floor and litter-slat waste management systems. The second objective was the development of procedures which would prevent extraneous contamination of the eggs from the time of collection through hatching. Gnotobiotic incubation, hatching and rearing methods were utilized. The bacterial count of shells of eggs from breeders in the sloping floor system were significantly less than that for egg shells of breeders in the litter-slat system. Day-old chick bacterial contamination was low with no marked difference between systems. More types of enteric bacteria were isolated from chicks of breeders in litter-slat systems when eggs were untreated or dipped in a quarternary ammonium and chicks chill stressed. There were no differences however, in the number of types of enteric bacteria isolated from chicks of breeders in either sloping floor or litter-slat systems when eggs were sterilized using mercuric chloride and chicks chill stressed. (Kehl-East Central)

2260 - A1, B1, D1, E1 300

## BEEF CATTLE FEEDLOT WASTE MANAGEMENT RESEARCH IN THE GREAT PLAINS

North Central Region, Agricutural Research Service, U. S. Department of Agriculture, Lincoln, Nebraska
T. M. McCalla
Control of Agriculture-related Pollution in the Great Plains, Seminar, Lincoln, Nebraska, July 24-25, 1972, p. 49-61, 4 tab., 184 ref.

Descriptors: *Research and development, *Cattle, *Great Plains, *Feedlots, *Design, Agricultural runoff, Soil contamination, Groundwater, Odor, Costs, Regulation, Diseases

The Agricultural Research Service, USDA and the Agricultural Experiment Stations are carrying on animal waste management research on beef cattle feedlots in the Great Plains. A summary of this research was presented before a meeting sponsored by the Great Plains Agricultural Council in Fort Collins, Colorado, March 13-15, 1972. Results of this reseach are discussed, calling attention to some of the areas that need additional emphasis. The topics that were briefly examined were (1) runoff from beef cattle feedlots, (2) soil pollution, (3) groundwater, (4) odors, (5) land-loading, (6) disease problems, (7) cost of establishing animal waste management practices, (8) regulatory aspects, (9) confinement house feeding and (10) manure as feed. It was concluded that some waste management systems for dirt beef cattle feedlots have been developed that are both workable and economical to construct. The study also concluded that much remains to be done to develop better designs for animal waste management, both on dirt lots and in confinement housing units. Studies are underway on the use of manure as feed and to determine the maximum rate of land application of effluent and manure from feedlots. Odor continues to be a feedlot problem. (Kehl-East Central)

### 2261 - B2, C3, E2 300

### DISPOSAL OF FARM ANIMAL WASTES THROUGH THE SOIL

Oregon State University
M. G. Cropsey and V. Van Volk
Agricultural Engineering Annual Report of Research 1971-72, Agricultural Experiment Station, Oregon State University, Corvallis. 1972, 24 p. 1 fig., 14 tab.

Descriptors: *Waste disposal, *Cattle industry, *Irrigation, Slurries, Chemical properties
Identifiers: *Land disposal, *Waste water quality

Disposal of livestock manure through an irrigation pumping system has proven economically successful, but some questions still need to be answered. The objective of this study was to determine the effect of large and frequent applications of dairy cow wastes on the soil. Another study objective was to determine the quality of waste water in the soil and in the drainage water from such soil sites. The Oregon State University Dairy Farm was used for the study. It was determined that dairy manure slurry should not be applied the first year or two to a soil plot that has recently been installed with drain tile. This is advised because the slurry will short circuit through the freshly dug soil to the drain tile. When compared with the effluent applied there was a considerable reduction in TS, BOD and all forms of phosphorus and nitrogen in the dry wells and the drain tile. A considerable portion of both the liquids and solids was observed to be retained either in the soil or on the surface. It was observed that the wind has considerable influence over the distribution of the manure water slurry. Recommendations for further investigation and some advice on application is given. (Kehl-East Central)

### 2262 - B1, C2, D1 600

### PROPERTIES RELATED TO MATERIALS HANDLING

Agricultural Engineering Department, North Dakota State University, Fargo
G. L. Pratt
Presented at Animal Waste Conference on Standardizing Properties and Analytical Methods Related to Animal Waste Research, American Society of Agricultural Engineers, Chicago, Illinois, December 11 12, 1972. 2 fig., 2 tab., 21 ref.

Descriptors: *Physical properties, Waste storage, Transportation, Waste disposal, Pumping, Separation techniques, Filtration, Centrifugation, Design
Identifiers: *Waste management, Dilution, Loading, Gutter flushing, Settling tanks

Manure and modified manure have a variety of forms such as solid and diluted. These forms must be considered in developing an analysis of handling systems for these materials. Loading, storage, transport and disposal are the basic handling processes that are involved. Under the heading of manure transport, the aspects discussed are pumping, pipeline transport of manure and gutter flushing. Liquid solid separation is discussed in terms of settling tanks and channels, filters and centrifuges. There are several factors that affect the quality of manure. They are: (1) differences in the basic wastes from different animals, (2) the animal's age, (3) the ration fed to the animals, (4) animal environment, (5) manure moisture and (6) the treatment processes that manure may be exposed to. Tables on the differences in quality and in production rates of manure for different kinds of animals are given. Also additional figures are given to further define characteristics of manure that will influence the design of handling systems. (Kehl-East Central)

### 2263 - A1, D4, E3 100

### KINETICS AND ECONOMICS OF ANAEROBIC DIGESTION OF ANIMAL WASTE

Department of Chemical Engineering, Missouri University, Rolla 65401
J. L. Gaddy, K. L. Park, and E. D. Rapp
Water, Air, and Soil Pollution, Vol. 3, No. 2, p. 161-169, June, 1974. 2 fig., 2 tab., 15 ref.

Descriptors: *Kinetics, *Economics, *Animal wastes, Feedlots, Waste disposal, Waste treatment, Carbon dioxide, Methane
Identifiers: *Anaerobic fermentation

During the process of raising cattle in this nation, approximately 1.006 × 10(12) kg (Ensminger, 1972) of solid waste (manure) are generated. The natural decays process disseminates the manure so that no harmful effects result when the animals are concentrated in large feedlots for fattening. The quantities of manure accumulate and create serious health hazards and pollution. This animal waste contains harmful bacteria, imposes a high biological oxygen demand on our waterways, and has an objectionable odor. A scheme, based on the process of converting animal waste to $CO_2$ and $CH_4$ by the autocatalytic process of anaerobic fermentation, for waste disposal from large feedlots is presented. This process design is based on kinetic data from the literature which are fitted to a kinetic model including diffusional resistance. An economic incentive for this process is provided by the sale of the $CH_4$. A return on investment of 23% yr.(1) from the sale of $CH_4$ appears to be possible for a large feedlot. (Kehl-East Central)

### 2264 - A8, B1, C5, D3 100

### LARVICIDAL ACTIVITY TO FLIES OF MANURE FROM CHICKS ADMINISTERED INSECTICIDE-TREATED FEED

College of Tropical Agriculture, Hawaii University, Honolulu
M. Sherman, G. H. Komatsu, and J. Ikeda
Jonrnal of Economic Entomology, Vol. 60, No. 5, p. 1395-1403, October, 1967. 2 tab., 10 ref.

Descriptors: *Insecticides, *Feeds, *Poultry, *Larvae
Identifiers: *House flies

A study was done to determine the effectiveness of 44 insecticides administered in the feed of chicks in controlling the larvae of 4 species of house flies. The insecticides included 1 chlorinated hydrocarbon, 6 phosphates, 1 carbonate, 6 phosphorothionates, 9 carbamates, 2 phosphorothiolates, 2 phosphonotrithioates, 10 phosphorodithioates, 3 phosphonodithioates, 1 phosphorotrithioate, and 3 phosphonothioates. The fly species included **Musca domestica L.; Fannia pusio** (Wiedemann) **Chrysomya megacephala** (F); and **Parasaracophaga argyrostoma** (Robineau-Desvoidy). **P. argyrostoma** was the most tolerant species to insecticide-containing manure. Eleven of the insecticides were highly toxic to at least 3 of the species after passage through the chick. The larval mortality was also determined in droppings inoculated directly with the insecticides. Relatively low levels of 20 of the insecticides were effective in controlling at least 3 species by this method of administration. Tables listing the insecticides and their effects on the larvae are given. (Kehl-East Central)

### 2265 - B2, E2 100

### SPRAY IRRIGATION OF DAIRY CATTLE MANURE EFFLUENT FOR MAXIMIZING CROP PRODUCTION

D. E. Baker, D. L. Stoddard, and R. M. Eshelman
Compost Science, Vol. 16, No. 1, p. 10-15, January-February, 1975. 12 tab.

Descriptors: *Spray irrigation, *Cattle, *Dairy industry, *Effluent, *Crop response, Nitrogen, Soybeans, Pennsylvania
Identifiers: Corn

A study was conducted at Green Valley Farms, Avondale, Pennsylvania, with the objective of developing a system which would use cow manure effluent in a pollution-abatement program which would insure high corn yields and reduce the cost of fertilizer. Experimental plots were established to supply three replications and three variable treatments in early May after plowing and disking. The variable treatments included the normal farm fertilization (check), manure effluent and manure effluent plus solution N (Uran-30). Corn and soybeans were planted and monitored. The soil testing and forage analyses yielded the following guidelines. The potential for corn at Green Valley using manure effluent should be 200 bushels of grain or 30 tons of silage per acre. The nitrogen requirements would be about 300 pounds of N per acre. Of the 300 pounds, 60 would be released by the soil, 15 would be from starter fertilizer and the remaining 225 would be supplied with manure effluent and fertilizer N added to it. Adjustments would be necessary for supplying the N requirements of other crops. Grass silage crops should receive approximately 50 pounds of fertilizer N for each cutting. Nitrogen fertilization of soybeans requires further study. All Legumes should be inoculated to allow maximum fixation of nitrogen from the atmosphere. Addition of nitrogen at the time of maximum utilization by the crop might enable greater fixation from the atmosphere as well as greater efficiency from applied nitrogen. (Merryman-East Central)

### 2266 - C1, E3 400

### VALUE OF DRIED CATTLE MANURE AS A FEEDSTUFF FOR POULTRY

Division of Poultry Science, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel
B. Lipstein
Feedstuffs, Vol. 45, No. 24, June 11, 1973. 4 fig., 19 ref.

Descriptors: *Feeds, *Poultry, *Energy, *Performance, *Nitrogen
Identifiers: *Dried cattle manure, Broilers, Laying hens

The objectives of this study were to determine (a) the effect of rations containing dried cattle manure (DCM) on the well-being and performance of growing and laying chickens, and (b) the utilization of the energy and nitrogen found in DCM by these birds. DCM was substituted in different amounts (up to 30%) for sorghum grain and pulverized basalt rock in the diets of broilers and laying hens. The DCM seemed to be devoid of any caloric value for growing birds; whereas for layers, its ME content was approximately 500 kcal./kg. The apparent retention of the nitrogen found in DCM (equivalent of 12% crude protein) appeared to be very low. Hence, DCM is unsuitable as a dietary ingredient unless the purpose is lower nutrient density. (Merryman-East Central)

### 2267 - E3 300

### OBSERVATIONS ON THE NUTRITIVE VALUE OF CHICKEN MANURE FOR CATTLE

Department of Animal Husbandry, Cornell University, Ithaca, New York
L. S. Bull and J. T. Reid
Unpublished Report, Cornell University, Agricultural Experiment Station, 1965, 12 p. 7 tab., 13 ref.

Descriptors: *Feeds, *Nutrition, Poultry, Cattle, Performance, Nitrogen
Identifiers: *Dried poultry manure, *Refeeding

Observations are made concerning the use of air-dried chicken manure (ADM) as a nitrogen source for cattle. Specific experimental objectives were: (1) To study the acceptability of chicken manure as a part of the diet of dry and milking cows and (2) To determine the degree to which young, growing ruminants utilize the nitrogen, energy and nutrients of chicken manure. It was determined that: (1) Both cows and growing cattle consumed sufficient quantites of dried, "pure" chicken manure when added to low nitrogen diets to satisfy their nitrogen requirements. (2) The rate of chicken manure acceptance was determined by preparation method, the ration's physical properties, the type of feeds to which it is added, and individual preferences. (3) Satisfactory performance in terms of body weight gain and milk production, flavor and composition was obtained from diets with ADM as a major source of nitrogen. (4) Additions of ADM to a low-nitrogen basal diet resulted in an increase in digestibility of dry matter, energy, nitrogen, ether extract, and carbohydrate. With additional ADM increments, the digestibility of nitrogen increased progressively whereas nitrogen retention decreased progressively. (5) No digestive upsets or malfunctions could be attributed to feeding of ADM. (7) The ADM was not found to have large numbers of Salmonella or coliform organisms. (8) Chicken manure's main nutritive value is in the nitrogen, calcium and phosphorus it contains. (Merryman-East Central)

2268 - A8, D3 300

### FLY CONTROL ON POULTRY FARMS

Extension Entomologist, Cooperative Extension Service, College of Agriculture and National Resources, The University of Connecticut, Storrs
M. G. Savos
Publication No. 72-12, Cooperative Extension Service, University of Connecticut, Storrs, 1972, 2 p.

Descriptors: *Insecticides, *Fly control, Sanitation, Open floor system, Manure pit system, Cage system

Successful fly control programs involve sanitation and the use of insecticides. Manure management to minimize fly breeding was discussed briefly. A list of insecticides which can be applied to manure pits was given. (McQuitty & Barber-University of Alberta)

2269 - A1, E2 400

### MANURE ON MILLET

United States Department of Agriculture
Agricultural Research, Vol. 20, No. 2, p. 16, 1971.

Descriptors: Ammonia, Toxicity, Nitrates
Identifiers: *Manure, *Millet, *Application rates,

Application of 65 tons/acre of dry cattle manure in the surface 8 inches of soil had no harmful effects on root development of millet in Alabama tests; however, when the same amount of manure was applied as a continuous layer (laid as a subsurface layer to simulate plowed-in manure), millet roots were considerably restricted, probably due to inadequate oxygen supplies rather than ammonia toxicity. The nitrate content of percolating water was increased by the plowed-in layer of manure, but not by the incorporated manure. Top growth of millet was increased by both manure treatments, but the increase in growth was greater for the incorporated than for the plowed-in manure. (McQuitty & Barber-University of Alberta)

2270 - A2, B1 400

### BRAKING FEEDLOT RUNOFF

United States Department of Agriculture
Agricultural Research, Vol. 19, No. 2, p. 5, February, 1971. 1 fig.

Descriptors: *Runoff control, *Feedlots, *Nebraska, Water pollution, Groundwater, Sampling,
Identifiers: Soil cores

This article reports on two management systems that limit pollution of streams and groundwater from beef cattle feedlots which are currently under development in Nebraska. Collection basins are utilized to trap the runoff. Runoff recording equipment and groundwater sampling wells have been installed at two test feedlots. At one feedlot, steel cased wells (caissons) have been installed to a depth of 12 ft. to allow a study of soil gases and pollutants moving downward under various conditions in the feedlot. Soil cores have been and are being taken for analysis. (McQuitty & Barber-University of Alberta)

2271 - A5, A6, B1, D1 400

### POULTRY HOUSES THAT MAKE GOOD NEIGHBORS

United States Department of Agriculture
Agricultural Research, Vol. 20, No. 6, p. 12, 1971. 2 fig.

Descriptors: *Odor, *Dusts, *Ventilation, Ammonia, Gases, Water
Identifiers: *Poultry houses, Spray chambers

ARS scientists are experimenting with spray chambers for elimination of odor and dust emmissions from poultry houses. In the spray chamber, which is located next to the exhaust fans, water combines with ammonia and other malodorous gases and carries them away in solution. Dust is also trapped by the water spray. (McQuitty & Barber-University of Alberta)

2272 - A1, C3, E2 400

### MANAGEMENT PROCEDURES FOR EFFECTIVE FERTILIZATION WITH POULTRY MANURE

Department of Soils and Plant Nutrition, California University, Davis 95616
Compost Science, Vol. 16, No. 1, p. 5-9, January-February, 1975. 6 fig., 3 tab., 16 ref.

Descriptors: *Poultry, *Fertilizers, *Nitrogen, *Crop response, Ammonia, Nitrites, Toxicity, Nitrificaiton
Identifiers: *Excreta, *Land disposal, Uric acid

Animal manures utilized effectively as fertilizers for crop production promote efficient recycling of mineral and energy resources while providing an outlet for large quantities of animal waste. The experiments reported upon were designed to evaluate the use of ammonia, nitrate, and uric acid from poultry manures upon corn crops. Conclusions concerning the use of poultry manures as nitrogen fertilizers are: (1) the decomposition of uric acid in fresh poultry manure releases substantial amounts of $NH_3$, (2) if rates of application of manure are kept low, the toxicity problem can be avoided altogether, (3) with higher rates of application, an incubation period of about one month after application and before planting will allow for nitrification of the ammonia produced, (4) incorporation of carbonaceous waste materials, such as straw, with poultry manure fertilizers can reduce potential toxicity hazards. (Battles-East Central)

2273 - A2, A9, B1, E3 400

### PROGRESS REPORTED IN HANDLING ANIMAL WASTES, RECYCLING IN FEED

Editor of Feedstuffs
D. Natz
Feedstuffs, Vol. 44, p. 2, 53, February 14, 1972.

Descriptors: *Recycling, *Feeds, Swine, Proteins, Costs, Agricultural runoff
Identifiers: *Refeeding, *Dried poultry waste, *Waste management, Continuous feeding, Food and Drug Administation

The author reviews the Cornell 1972 Conference with emphasis on the papers dealing with refeeding. Bergdoll's recommendation of feeding dried poultry waste from layers (which are fed few antibiotics or other drugs) to beef cattle is cited in particular. (Whetstone, Parker, & Wells-Texas Tech University)

2274 - E3 400

### FEEDING WASTES

Feedstuffs, Vol. 43, p. 14, December 11, 1971.

Descriptors: *Feeds, *Nutrients, *Performance
Identifiers: *Dried swine feces, *Dehydrated poultry wastes

Tests at Michigan State University in the feeding of dried swine feces (DSF) and dehydrated poultry waste (DPW) to swine are described. It was concluded that finishing pigs will consume corn-soy rations containing up to 22 percent of the DSF at 90 to 95 percent full appetite, that rate and efficiency of gain will be depressed by the incorporation of DSF in corn-soy rations to replace all or most of the soybean meal, that inclusion of DSF does not affect flavor or acceptability of the meat, and that DPW is of somewhat less value than DSF in swine rations. (Whetstone, Parker, and Wells-Texas Tech University)

2275 - E3 400

### CATTLE AS AN ECONOMIC BASE FOR AN ECOLOGICAL LOOP

Hoffman-La Roche Inc.
P. Meinhardt
Feedstuffs, Vol. 43, p. 18, 20, July 3, 1971. 5 tab., 20 ref.

Descriptors: *Cattle, *Economics, *Feedlots, *Organic wastes, *Feeds
Identifiers: *Refeeding

Among the conclusions stated are the following: "1. Utilizing only organic wastes and marginal land, it may now be feasible to produce an abundance of beef without using human foodstuffs — the nature of the ruminant stomach, the genetic flexibility of cattle, and the worldwide acceptance of beef make this possible. 2. Beef may be produced on a large scale, at less than 5c per pound, by locating dry-lot breeding facilities and feedlots in and around cities — at urban fringes and in city dumps — even the manure becomes a valuable resource for refeeding, fertilizing, or producing electricity — a major source of economies are (1) close proximity for all production inputs to minimize transport costs; (2) nearness to cheap feeds (garbage); and (3) the production of beef close to urban markets using devalued land. Sufficient organic waste exists in most countries to feed an abundance of beef — waste vegetation, industry wastes, paper, manure, and even sewage, when properly fed and supplemented, can feed beef." (Whetstone, Parker, & Wells-Texas Tech University)

2276 - A1, B1 400

### THE FALLACY OF DEEP PITS FOR POULTRY HOUSES

Poultry Management Consultant, DeKalb AgResearch, Inc., DeKalb, Illinois
J. W. Claybaugh

Descriptors: *Design, *Ventilation, Nutrients, Costs, Rodents
Identifiers: *Deep pits, *Poultry houses

The major disadvantage of a deep pit is the deterioration in nutrient quality of the manure. Others are the additional cost of the building, the possibility of water leakage leading to anaerobic conditions in the pit, and the attraction of a deep pit for home-seeking rodents. To obtain good air flow patterns, separate ventilaing systems may be required for birds and pit. (Whetstone, Parker, and Wells-Texas Tech University)

2277 - A1, E2 100

### LONG-TERM EFFECTS OF MANURE, FERTILIZER, AND PLOW DEPTH ON CHEMICAL PROPERTIES OF SOILS

### AND NUTRIENT MOVEMENT IN A MONOCULTURE CORN SYSTEM

**Crop and Soil Sciences Department, Michigan State University, East Lansing 45823**
**M. L. Vitosh, J. F. Davis, and B. D. Knezek**
**Journal of Environmental Quality, Vol. 2, No. 2, p. 296-299, April/June, 1973. 5 tab., 20 ref.**

**Descriptors: *Fertilizers, *Chemical properties, *Soils, *Nutrients, *Organic matter, Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Silage**
**Identifiers: *Manure, *Plow depth, *Nutrient movement, *Corn, *Application rates, pH**

An evaluation of soil chemical properties, organic matter and nutrient accumulations, and nutrient movement and recovery after 6 and 9 years annual fertilizer and manure applications to continuous corn was conducted on two soil types — Conover-Hodunk loam and Metea sandy loam. The field experiments took place at the Michigan State University Soils Farm at East Lansing. Plow depths of 18 versus 30 cm had little or no effect on soil test values or nutrient accumulation patterns in the surface of a Conover-Hodunk loam soil. The pH value of both soils decreased slightly more than 0.1 pH unit per year with the annual application of 168 kg of N/ha as ammonium sulfate. Available P, soil organic matter, and exchangeable K, Ca, and Mg increased with increasing rates of manure. The differential removal of nutrients by grain and silage had no effect on soil available P. Soil test changes for Ca, K, and Mg were proportional to the net addition of each nutrient; but less than 30% of the net nutrients added could be accounted for in surface samples from the silage area where 67.2 tons of manure was applied annually. The most favorable rate of manure for the Metea-sandy loam soil was 22.4 metric tons ha (10 tons/acre). Larger applications caused a significant buildup of exchangeable K in the surface and subsurface horizons and resulted in inefficient use of soil nutrients. The K buildup was less critical on the loam soil or where silage rather than grain was removed. (Battles-East Central)

2278 - A9, B2, D4, E3 200

### CONVERTING SWINE WASTE INTO A NUTRIENT SOURCE FOR SWINE

**B. G. Harmon, D. L. Day, A. H. Jensen, and D. H. Baker**
**Proceedings, Illinois Pork Industry Day, Paper No. As-665d, University of Illinois, December 4-11, 1973, p. 15-19. 1 fig., 4 tab., 10 ref.**

**Descriptors: *Recycling, Feeds, Nutrients, Proteins, Fermentation, Parasites**
**Identifiers: *Swine, *Oxidation ditch mixed liquor, Illinois**

In studies conducted at the University of Illinois, waste serves as a substrate in a fermentation system for the production of single-cell protein. The biological enhancement of the substrate is carried out in an oxidation ditch. Swine producers are currently using these ditches in waste management programs without realizing any nutrient return from the products. Nutritive value has been shown for products of the ditch in studies conducted with rats. No liquid effluent needs to leave the building since water must be added to the oxidation ditch in order to maintain the constant composition and level of the ditch. Precautions should be taken with the refeeding program described in this paper. Under abnormal conditions, nitrate levels of 5,000 parts per million have been measured. Such levels are toxic to swine. Management practices such as effective internal parasite control become exceedingly important, since ascarid eggs can be cycled back to the swine during the recycling process. (Cartmell-East Central)

2279 - A1, D1, E1, F1 200

### NUTRIENT RECYCLING—MODERN ENERGY MANAGEMENT

**President, Arizona Feeds, Tucson, Arizona**
**B P. Cardon**
**Presented at IES 18th Meeting, New York, May 1-4, 1972, p. 262-266. 9 fig.**

**Descriptors: *Nutrients, *Recycling, *Energy, Incineration, Feeds, Economics**
**Identifiers: *Waste management, *Land disposal, *Building materials**

Incineration, land disposal, and recycling as building materials are all options for waste disposal, but each has its inherent problems. Another option is a nutrient recycling approach in which energy of oxidation is used by selected microorganisms. The organisms are then harvested and used as a source of feed for animals. In this manner, the chemicals are recycled and the energy in the organic waste is captured in the microorganism cells and contributes to man's welfare as feed for livestock. Perhaps all or none of these methods may prove viable in the future, but one thing is clear. A manageable economic solution must be found to the pollution problem and the recycling of pollutants if the livestock industry is to continue to supply meat by-products to the public at a relative cost consistent with experiences of the past. (Merryman-East Central)

2280 - A1, A4 100

### THE NITROGEN STATUS BENEATH BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA

**U. S. Department of Agriculture, Lincoln, Nebraska**
**J. R. Ellis, L. N. Mielke, and G. E. Schuman**

**Descriptors: *Feedlots, *Nitrogen, *Soil profile, *Nebraska, Cattle, Soil contamination, Groundwater pollution**

The majority of the beef consumed in the United States comes from cattle fed in large, open, soil-surfaced feedlots in the Plains States and the Midwest. Feedlots are point sources of nitrogen since they provide intensive land use. The objective of this study was to examine the effects of beef-feedlot management systems on N accumulation in the soil profile and groundwater. Fifteen sites were selected in eastern Nebraska. Core samples were taken from feedlots, cropland cattle-use areas and from cropland adjacent to feedlots to evaluate the effects of different management practices on the movement and accumulation of nitrogen in the soil profile. The soil texture of the feedlots sampled ranged from clay to coarse sand with the age of the feedlots ranging from a few weeks to more than 50 years. The sites examined were ranked according to decreasing average $NO_3$—N in the core as follows: abandoned feedlot, feedlot-cropland, upland feedlot, corn (**Zea mays L.**) river-valley feedlot, profiles under feedlot mounds, alfalfa (**Medicago sativa L.**) grassland. The study concluded that feedlot management is an important consideration in the accumulation of $NO_3$ in the soil profile. (Kehl-East Central)

2281 - B2, D4 200

### EVALUATION OF AERATED LAGOONS AS A MEANS OF SWINE WASTE STABILIZATION

**G. E. Bennett**
**National Pork Industry Conference, Waste Management Workshop, November 9, 1967, 14 p. 5 fig., 13 ref.**

**Descriptors: *Aerobic lagoons, *Aeration, Design, Operation and maintenance, Odor**
**Identifiers: *Swine, *Waste stabilization**

It would appear that there is a reasonable possibility that modified aerated lagoons could be satisfactorily used for treatment of swine wastes. Conclusive determination of this fact would require actual experimentation and research. Potential advantages are odor control, space and volume requirements, and elimination of the need for frequent disposal of sludge solids. (Wetherill-East Central)

2282 - A5, B2, D4 200

### THEORY AND PRACTICE OF ANAEROBIC DIGESTERS AND LAGOONS

**Department of Agricultural Engineering, Ohio State University, Columbus, Ohio 43210**
**E. P. Taiganides**
**Proceedings, Second National Poultry Litter and Waste Management Seminar, College Station, Texas, September 30-October 1, 1968, p. 220-221. 3 fig., 1 tab., 14 ref.**

**Descriptors: *Anaerobic digestion, *Lagoons, *Poultry, *Design, Gases, Fermentation**
**Identifiers: *Malodors, Loading rates**

Basic advantages of anaerobic processes are the stabilization of organic wastes at high rates in continuous fermentation, at a wide range of temperatures and environmental conditions, and the production of a high energy, combustible gas, methane. These processes are suited to animal manure but the main limitation of the processes are malodors which emanate during the process. Design parameters for completely controlled and uncontrolled anaerobic processes in the treatment of poultry wastes are presented and discussed. Anaerobic digestion could prove to be one of the most effective methods of poultry waste disposal when research develops the engineering design criteria and means of controlling the odors associated intrinsically with the process. Design loading rates for anaerobic lagoons are 0.001 to 0.015 lb. volatile matter day cu. ft. of lagoon water volume. From the standpoint of odor acceptability, the recommended loading rate is 0.004 lb./day cu. ft. This is equivalent to about 15 cu. ft. of lagoon water volume hen. Digesters operating under controlled environment and at constant temperature above 70 F may be loaded at rates of 0.1 lb. Vm day cu. ft. On volumetric basis, 0.37 cu. ft. of digester volume hen is suggested. At this rate, the gas produced is expected to be about 0.4 cu. ft. hen/day. This gas could have a heat value of about 200 BTU. (Solid Wastes Information Retrieval System)

2283 - A2, B1 400

### COSTS OF CONTROLLING FEEDLOT SURFACE RUNOFF

**Agricultural Economics Department, Utah State University, Logan 84321**
**D. B. Nielsen and P. P. Olson**
**Utah Farmer-Stockman, Vol. 92, p. 10-11, October 5, 1972. 1 fig.**

**Descriptors: *Feedlots, *Agricultural runoff, *Costs, Utah, Runoff control**
**Identifiers: *Government assistance**

Of the 31 feedlots in Utah capable of handling 100 head or more, 26 were assessed in a study of runoff potential. It appears that an expense of 18c per head fed would be involved in correcting runoff conditions. Of the lots, 12 had no runoff problem, 6 needed minor improvements, 5 needed major improvements, and 3 would find it more economical to relocate. (Whetstone, Parker, &Wells- Texas Tech University)

2284 - E2, F1 300

### PROFITS FROM DAIRY MANURE APPLICATION

**Texas A&M University, College Station 77843**
**J. M. Sweeten, D. Forrest, A. C. Novosad, and A. Gerlow**
**"Results of 1974 Agricultural Demonstration — Harris County." Publication No. D-681, Texas Agricultural Extension Service, Texas A&M University, 1974, p. 51-52.**

**Descriptors: *Dairy industry, *Costs, *Profits, *Liquid wastes, Bermudagrass, Nutrients, Productivity**
**Identifiers: *Manure, *Land disposal**

Profits from applying dairy manure to Coastal bermudagrass were determined in a 1974 extension result demonstration in Harris County. On an 80-cow, 187 acre dairy farm, the meadow was divided into a one-acre manure-treated plot and a one-acre control plot which received no manure. Both plots were treated with 300 pounds of 13-13-13 fertilizer and 200 pounds of ammonium nitrate in mid-summer. Applications of liquid manure at the rate of 11,000 gallons per acre provided a net profit of $164 per acre on a forage quality and yield basis. The 11,000 gallons of manure contained only 55 pounds of N, 18 pounds of $P_2O_5$, and 73 pounds of $K_2O$. The net production value of liquid dairy manure amounted to 1.5c per gallon. (Cameron-East Central)

2285 - D4, E1 600

### POULTRY MANURE DISPOSAL AT CONVENTIONAL SEWAGE TREATMENT PLANTS

University of Connecticut, Storrs 06268
R. Laak, C. S. Shu, and J. J. Kolega
Presented at the 1974 Annual Meeting, American Society of Agricultural Engineers, Oklahoma State University, Stillwater, June 23-26, 1974, 17 p. 3 fig., 7 tab., 28 ref.

Descriptors: *Poultry, *Waste disposal, Sludge, Effluent, Chemical properties
Identifiers: *Sewage treatment plants, pH, Volatile acids, Activated sludge treatment process

The amount of poultry manure that can be added safely to an activated sludge process has been studied. The objectives of this laboratory study were to (1) choose the proper discharge time for poultry manure, (2) find the suitable dilution (sewage-to-manure ratio), (3) evaluate the effect of manure addition on the effluent quality defined by parameters such as $BOD_5$, COD, nitrate, phosphate, D.O., suspended solids, etc., (4) observe the excess sludge and gas production and (5) find the effect of the manure sludge on the digester. The study showed a 100 to 1 ratio of sewage to poultry manure added during night flows did not significantly affect the activated sludge treatment process. An activated sludge plant with one million gallon per day flow should be able to treat in 4 hours the night flows of manure produced by 17,000 birds. A pilot study is recommended to confirm the promising laboratory results. (Cameron-East Central)

2286 - A5 300

### IDENTIFICATION OF ODORS FROM CATTLE FEEDLOTS

Chemist, Air Pollution Research Center and Department of Soil Science and Agricultural Engineering, California University, Riverside.
E. R. Stephens
California Agriculture, Vol. 25, No. 1, p. 10-11, January, 1971. 1 fig., 1 tab.

Descriptors: *Odor, *Measurement, *Feedlots, *Cattle, California, Sampling, Chemical properties, Chromatography
Identifiers: *Identification, MR spectroscopy, Infrared spectroscopy, Mass spectrometry, Flame photometry

During 1967, 1968, and 1969, a small-scale project on the subject of feedlot odors was conducted in laboratories at the Statewide Air Pollution Research Center, the University of California, Riverside. The objective was to identify the odorant compounds from typical feedlot operations and to develop suitable chemical analytical methods for their detection and measurement. The project involved several phases, the first of which was sampling the air in or near the feedlot. The second phase involved analysis of odor-causing substances in the air by methods such as gas or liquid chromatrography, NMR spectroscopy, infrared spectroscopy, mass spectrometry, and flame photometry. The third phase was the analysis of subjective responses to humans to known concentrations of odoriferous air. From the study, it was discovered that the most important odorous compounds in feedlot air are the molecular amines, especially trimethylamine; but a contribution from other amines, ammonia, or other compounds cannot be ruled out. Furthermore, particular weather conditions or special feedlot operations may produce a different mix of odorants. (Solid Waste Information Retrieval System)

2287 - E3 400

### DIGESTIBILITY OF PROCESSED FEEDLOT MANURE

Colorado State University, Fort Collins, Colorado
G. M. Ward
Feedstuffs, Vol. 45, No. 28, July 9, 1973. 3 tab., 6 ref.

Descriptors: *Feeds, *Feedlots, *Cattle, *Sheep, *Proteins, *Performance
Identifiers: *Refeeding, *Cerola, Digestibility

Among the systems suggested to solve the current problem of feedlot manure utilization are several schemes for refeeding manure or fractions of the manure. The advantage that refeeding has over other systems is that the producers are the consumers and vice versa. The product cerola, discussed in this study, was produced from feedlot manure and fed to sheep to determine its digestibility. This source material was taken from a pen of Hereford steers receiving a ration of whole corn, hay and silage with a protein supplement. A description of the processing of the manure for feeding is given. Six crossbred lambs which averaged 61 lb. in weight were used in the digestion trial. The study showed that the nutrient digestibilities found were high considering the source of the product. An explanation for the higher percentage of crude fiber in Cerola as compared to corn is that poor digestibility of fiber is expected when a high concentrate diet is fed. The study also indicated that the protein intake (average 64 gm. of digestible protein) of these lambs would not support weight gains, but might be sufficient to maintain weight. Cerola is readily eaten by sheep and is highly digestible. Because of the encouraging results of this study, a processing plant to provide Cerola for feeding brood cows is being constructed at Sterling, Colorado. Results can be expected from these experiments this year. (Kehl-East Central)

2288 - A1, B2, D4, E2 100

### AEROBIC TREATMENT OF FARM WASTES

New Zealand Agricultural Engineering Institute, Lincoln
D. J. Hills
New Zealand Journal of Agriculture, Vol. 128, No. 4, p. 42-44, April, 1973. 3 fig.

Descriptors: *Agricultural wastes, *Waste disposal, *Anaerobic treatment, *Aerobic treatment, Lagoons, Odors, Oxidation, Activated sludge, Municipal waters, Livestock, Aerated lagoons, Legislation, Oxidation lagoons
Identifiers: *New Zealand, Oxidation ditches, Piggeries

Since the Water and Soil Conservation Amendment Act of 1971, farmers have had to consider alternative treatment methods of their wastes, particularly livestock wastes. The most widely used waste disposal systems in New Zealand were anaerobic lagoons and spray disposal. However, in situations where these methods cause odors or agravate poor soil characteristics, aerobic treatment must be considered. Oxidation ditches and mechanically aerated lagoons are both modified forms of the municipal activated sludge treatment process. This may be applied to beef cattle and poultry wastes but is especially useful in piggeries. Mechanically aerated lagoons also may be used in New Zealand in the future. Surface aeration is of value as a means for odor control of wastes which will be subsequently spread on land. Various agricultural operations are noted, with their specific problems. These include piggeries, dairy sheds, beef cattle feedlots, poultry houses, and livestock. (Prague-FIRL)

2289 - E3 400

### MOLASSES FROM MANURE?

Poultry Digest, Vol. 31, No. 208, April, 1972.

Descriptors: *Feeds, *Sludge, Proteins
Identifiers: *Manure, *Molasses, Sulphur dioxide

"The Sulphur Institute reports that sulphur dioxide, an air pollutant from power and industrial plants, can be cooked with sludge, protecting the organic amino acids, in the sludge from degradation, and enhancing the protein values." If sludge, why not poultry manure which has lost most of its nitrogen? (Whetstone, Parker and Wells-Texas Tech University)

2290 - A5, B1, D4 400

### NEW WASTE TREATMENT SYSTEM IS USED FOR HOGS

Agricultural Pollution Control Research Laboratory, Agricultural Engineering Department, Ohio State University
E. P. Taiganides
American Farmer, Vol. 47, No. 2, p. 6-7, 1972.

Descriptors: *Waste treatment, Separation techniques, *Liquid wastes, *Solid wastes, Odor, Biochemical oxygen demand, Aeration
Identifiers: *Swine, *Flushing

Although liquid systems have made it possible to mechanize manure handling to a greater extent than is possible with solid systems, new odor and water pollution problems have been created. Automated waste handling systems which do not create water or odor pollution will probably be in great demand in years to come. This study examined a treatment system in which flushing the manure out of the building played an important role. Flushing accomplished two things: (1) It prevented the release inside the building of noxious gases which affect the health and comfort of both animals and of the people working inside the building; (2) It ameliorated the problems of dust and odor and it automated manure removal. Flushing also enhanced the treatability of the manure in the aeration units outside the building by speeding up the liquification of the organic solids in the manure. At peak performance, an effluent of extremely high quality was produced. The BOD of the effluent was from 30-140 ppm and pH ranged from 6.5 to 8.4. There were no odors. The effluent was treated in an oxidation ditch, clarified, and recycled through the building as flushing water. The solids were screened out, aerated in an aerobic digestor, and stored before being pumped out for final disposal. There was trouble in getting the aerator to work properly but the problem was presumed to be in the wiring. Before a conclusion could be drawn on plant efficiency, its performance in freezing weather would have to be studied. (Kehl-East Central)

2291 - F1, D2, D4 E3 400

### FLY MANURE HIGH QUALITY PROTEIN SUPPLEMENT

Descriptors: *Feeds, *Proteins, Fertilizers
Identifiers: *Fly pupae, Manure, Flotation process

Poultry Digest, Vol. 29, p. 385, August, 1970.
Breeding colonies for pathogen-free houseflies were established. Eggs were collected and used to inoculate fresh poultry manure. The eggs hatch in five or six days and the larvae remove about 80 percent of the organic content and reduce the moisture content of the manure. The larvae and pupae are collected and processed into a high quality protein supplement. The economics appear favorable. (Whetstone, Parker, and Wells-Texas Tech)

2292 - A4, B2 300

### MANURE HOLDING PONDS FOUND SELFSEALING

Area Soil and Water Technologist, Stanislaus County, California
J. L. Meyer, E. Olson, and D. Baier
California Agriculture, Vol. 26, No. 4, p. 14-15, May, 1972.

Descriptors: *Waste storage, *Water pollution, *Poultry industry, *Waste Water (Pollution), Salts, Sludge, Biochemical oxygen demand, Nitrogen, California
Identifiers: *Manure holding ponds, *Self sealing

Findings in a study of waste pond operations are reported. In the past, waste waters from poultry and dairy operations flowed to stream beds where they became part of the stream. Improved practices are imperative, since such waste waters are high in BOD, nitrates, dissolved solids, offensive constituents, and bacteria. One alternative available to handle animal wastes is the use of manure waste ponds. A test was run on 17 ponds in California which represented a wide range of soil textures, water table depths, and age. Results of various experiments are included in the article. Apparent anaerobic nitrogen losses of considerable magnitude occur under normal pond operation. Since much of manure dry solids are salt, ponds should be emptied frequently or whenever salt content reaches 2,900 ppm. A study of soil nitrate and salt showed that after several months of use, levels of nitrate and salt in soil solutions from below ponds showed very small changes. There is a very low rate of water loss from manure ponds. Sludge which developed on each soil bottom had very low nitrate-nitrogen contents and very high BOD values. Seepage of water from ponds amounted to only 1 mm per day. Soil solutions below the ponds had a lower concentration of all nutrients than adjacent well waters after 15 months. Thus artificial seals inside manure-laden reservoirs are not recommended. (Solid Waste Information Retrieval System)

2293 - A1, E2 100

### NITRIFICATION IN SOILS INCUBATED WITH PIG SLURRY

Agricultural and Food Bacteriology Department, Queen's University of Belfast, and Department of Agriculture, Newforge Lane, Belfast BT9 5PX, Northern Ireland
J. E. Cooper
Soil Biology and Biochemistry, Vol. 7, p. 119-124, 1975, 4 fig, 2 tab, 12 ref.

Descriptors: *Nitrification, *Soils, *Slurries
Identifiers: *Swine, *Land disposal, *pH, Nitrifying bacteria

Coinciding with the increased use of intensive methods of rearing livestock is the common practice of spreading animal slurries on agricultural land. Factors most likely to limit the use of slurry on cropland are the same as those applying to sewage sludge: concentration of heavy metals, survival of pathogenic bacteria and nitrogen content (Dotson, 7973). This study's objectives were: (1) to determine the effect of different quantities of slurry on nitrification and nitrifying bacteria; and (2) to compare nitrification patterns in slurry-treated soils with those in soils receiving $(NH_4)_2SO_4$ solutions of comparable nitrogen content. The results of the study are discussed in relation to heterotrophic nitrification in soils, and the practical implication of spreading slurry on agricultural land. Nitrification incubation studies (5 weeks at 30 degrees C) were made in a natural (PH 7.1) and an acid (PH 5.8) soil receiving varying concentrations of pig slurry and $(NH_4)_2SO_4$ solution. Observations at weekly intervals were made of mineral-N and pH changes and inorganic salts media were used to obtain separate estimates of the numbers of $NH_4$ +/— -N- and NO(2)-N- oxidizing bacteria. $NH_4$ +/— was nitrified to a greater extent than $(NH+_4)$ $(NH+_4)_2SO_4$ in an acid soil. In the neutral soil, an accumulation of NO(2)-N resulted from slurry additions. The pH of both soils, was raised more by the slurry than the $(NH_4)_2SO_4$ and nitrification was most rapid in a 2 week period of elevated pH following slurry applications in the acid soil. (Kehl-East Central)

2294 - D2, D4, E3 400

### FERMENTED POULTRY MANURE RECYCLED

Poultry Digest, Vol. 30, p. 190, 1971

Descriptors: *Recycling, *Fermentation, *Poultry, Slurries, Bacteria
Identifiers: Heat treatment

Walter Langston, of Midwest Research Institute, "has worked with a 250,000-layer operation in which manure is collected in a tank where it is made into a slurry so it can be pumped. It is heat treated to kill disease organisms. Then, bacterial fermentation is used to upgrade the material so that it can be fed to the animal or bird, either as a wet material or dried. The entire process takes less than 36 hours." No ill effects appeared with recycling through the same chickens several times. (Whetsone, Parker, and Wells-Texas Tech University)

2295 - D2, E3 400

### POULTRY MANURE DRIED WITH MICROWAVES

Poultry Digest, Vol. 30, p. 391, 1971

Descriptors: *Poultry, *Drying, *Microwaves, *Costs, Feeds, Fertilizers
Identifiers: *Great Britain

A British firm is reported to have developed a microwave drier with a one-ton per hour output. Costs of $2.40 per ton for continuous operation or $5 per ton on a forty-hour week are quoted for the machine which is priced between $50,000 and $60,000. "Dried manure emerges in a wide continuous strip. Since there is no odor, it would make a suitable garden fertilizer, but it is believed that the main outlet will be for ruminant feeds." (Whetstone, Parker, and Wells-Texas Tech University)

2296 - A4, E2 400

### FOREST LAND AND MANURE DISPOSAL

Poultry Digest, Vol. 30, p. 553, November, 1971

Descriptors: *Waste disposal, *Forest management, Nitrogen, Liquid wastes, Groundwater pollution
Identifiers: Tanker spreader

"Liquid manure was applied with a tractor-drawn tank spreader across a 30-ft. swath in a white pine plantation." It dried quickly and was dispersed by rains within two months. Flies were not attracted and the trees used the nitrogen effectively. Application rates must be governed to avoid nitrogen build-up in groundwater. (Whetstone, Parker, and Wells-Texas Tech University)

2297 - A5, B2, D4 400

### MANURE HOLDING POND ODOR CONTROL

R. A. Parsons
Poultry Digest, Vol. 31, p. 386, 1972.

Descriptors: *Aeration, Size
Identifiers: *Manure holding pond, *Odor control, *Floating aerators, *Sprinklers

Sprinklers or floating aerators are recommended for odor control on overloaded ponds. "For 10,000 hens, an aerator that puts 60 to 90 pounds of oxygen daily into the pond is suggested." (Whetsone, Parker, and Wells-Texas Tech University)

2298 - D2, E3, F1 400

### DRIED POULTRY WASTE AS FEED

F. Price
Poultry Digest, Vol. 31, p. 348-349, 1972.

Descriptors: *Feeds, *Drying, *Costs, *Proteins, *Economics
Identifiers: *Dried poultry waste, *Refeeding, Europe

In European practice poultry manure is dried at lower temperatures and the exhaust gases are often run through an afterburner. Both practices reduce odors. Drying costs of $6 to $37 per ton have been reported. Protein contents range from three to 30 percent with low protein content accompanying high-temperature drying and drying of old manure. The value of DPW in poultry ration is about $18 per ton. It may be more valuable for ruminants than for poultry since ruminants can convert urea as uric acid to body proteins. Poultry can not. (Whetstone, Parker, and Wells-Texas Tech University)

2299 - D2, E3 400

### DPW RECYCLING FACTS UPDATED

H. C. Zindel
Poultry Digest, Vol. 31, p. 125-126, 1972.

Descriptors: *Recycling, *Costs, *Performances, Layer hens, Dehydration, Nutrients
Identifiers: *Dried poultry wastes, * Refeeding

Studies at Michigan State University, including recycling 35 times with rations containing 12.5 percent and 25 percent DPW, have indicated that the practice is safe. No build-up of heavy metals has occurred. Operation costs will vary between $12 and $16 per dried ton without afterburners. With them, costs will about double. Properly processed and properly stored DPW "has a place in the list of ingredients for all animal rations." (Whetstone, Parker, and Wells-Texas Tech University)

2300 - B1, E3 400

### MANURE STORAGE TIME AFFECTS VALUE OF DPW

Poultry Digest, Vol. 31, p. 205, 1972.

Descriptors: *Waste storage, *Proteins
Identifiers: *Dried poultry waste, *Refeeding, *Feed value

The protein percentage (dry basis) of dried poultry waste decreases from 30.3 for seven-day storage to 18.3 for 90-day storage of the manure before drying. Intermediate values are tabulated. After 31 recyclings of DPW with collection and drying at intervals averaging 12 days, the crude protein at the end of the first cycle was 29.7 percent. For a ration percentage of 12.5 percent, the crude protein after the 31st cycle was 27.9 percent. Phosphorus content was 2.4 percent after the first, 2.8 percent after the 31st. Egg production was 62.4 percent on the 12.5 percent refeed, 50.6 percent on the control diet (zero refeed), and 50.2 percent on 25 percent refeed. (Whetstone, Parker, and Wells-Texas Tech University)

2301 - A1, D2, E3 400

### OTHER FERTILIZER USES FOR DRIED MANURE

Poultry Digest, Vol. 31, p. 136, 1972.

Descriptors: *Fertilizers, *Reclamation
Identifiers: *Dried poultry waste

Dried poultry manure in excess of market demand has proved useful in Pennsylvania on highway embankments, highly-acid strip mine lands, and other wastelands. (Whetstone, Parker, and Wells-Texas Tech University)

2302 - A1, C3, E2 400

### WHY POULTRY MANURE VARIES AS FERTILIZER

Poultry Digest, Vol. 31, p. 90-91, 1972.

Descriptors: *Poultry, *Fertilizers, *Nitrogen, Phosphorus, Potassium, Moisture content
Identifiers: *Manure variation

Many farmers distrust poultry manure as a fertilizer because of uncertainty as to its content of nitrogen, phosphorus, and potassium. With "as is" samples in Riverside County, California, values ranged as follows: nitrogen: 0.5 percent — 6.0 percent by weight, Phosphorus: 0.5 percent — 3.0 percent, potassium: 0.4 percent — 2.0 percent, and water: 7.8 percent—69.5 percent. Major causes of the variation are moisture content, feed of poultry, and age of manure at time of drying or of delivery. (Whetstone, Parker, and Wells-Texas Tech University)

2303 - A8, B1 400

### CHICKENS CONTROL FLIES FROM MANURE STACK

Poultry Digest. Vol. 31, p. 546. 1972.

Descriptors: *Poultry, *Dairy industry
Identifiers: *Fly control, *Manure, Maggots

"Chickens which eat fly maggots in dairy manure stacks at the University of Wisconsin's Electric Research Farm are doing a good job of fly control . . ." Two hundred fifty cockerels are housed in a yard to which the daily manure production is brought. (Whetstone, Parker, and Wells-Texas Tech University)

2304 - A9, E3 400

### DATA NEEDED ON SAFETY OF RECYCLING WASTE

Poultry Digest, Vol. 31, p. 294, 1972.

Descriptors: *Recycling, Pathogenic bacteria, Safety
Identifiers: *Refeeding, *Food and Drug Administration, Residues

The Food and Drug Administration is watching research results on the content of pathogens and residues harmful to animals and food in recycled litter. Until convinced of its safety, approval will continue to be withheld. Approval, if it comes, will be on a process-by-process basis as the safety of each process is established. (Whetstone, Parker, and Wells-Texas Tech University)

2305 - E3 400

### PROCESSED POULTRY MANURE AS A FEEDSTUFF

Poultry Digest, Vol. 31, p. 537, 1972.

Descriptors: *Poultry, *Performance, Phosphorus, Amino Acids, Feeds
Identifiers: *Refeeding, *Feces

Poultry feces uncontaminated with litter may be fed to laying hens without detrimental effects on the health of the hens or on the taste of the eggs. DPW has a low energy content and is useful primarily for its phosphorus and amino acid content. It should not be fed to broilers and turkeys. Hens on DPW eat more (to get more energy) and produce more manure. (Whetstone, Parker, and Wells-Texas Tech University)

2306 - A5, A8,B1 400

### HOW NUTTING PRE-DRIES MANURE IN DEEP-PIT HOUSE

Poultry Digest, Vol. 31, p. 385-386, 1972.

Descriptors: *Poultry, Drying, Moisture content, Odor
Identifiers: *Nutting, *Waste accumulation, *Deep pit house, Flies

Cones of manure build up on 1x4's some five inches apart suspended between cage and pit. The manure is air dried by an exhaust fan and pushed off into the pit semiannually. A four-year accumulation in the pit has a moisture content of 20 to 30 percent and a depth of 40 inches. It has little odor and attracts few flies. (Whetstone, Parker, and Wells-Texes Tech University)

2307 - A2, C1 700

### FECAL COLIFORM POLLUTION IN AN AGRICULTURAL ENVIRONMENT

J. K. Jones
M. S. Thesis, Department of Microbiology, Colorado State University, 1971, 122 p. 7 fig. 10 tab. 84 ref.

Descriptors: *Water pollution, *Agricultural runoff, *Feedlots, Livestock, Coliforms, Ammonia, Nitrogen, Biochemical oxygen demand
Identifiers: Membrane filter

A study was undertaken with the primary objective of characterizing the types and numbers of coliform organisms occurring in fresh and stored livestock fecal wastes and in waters polluted by these wastes. A membrane filter procedure was used to detect the total coliform and fecal coliform groups and these groups were used to examine the significance of the organisms as indicators of livestock waste pollution. Fresh bovine, ovine and equine fecal samples showed an overall range of total coliform counts of 7400 to 65 million per gram dry weight and of fecal coliform counts, 5800 to 60 million per gram. In an environment of stored bovine manure, a reduction in numbers of coliforms occur. Complex interactions of the coliform population with the natural environment determine the types and numbers of indicator organisms that reach water supplies in runoff from a livestock rearing area. The ammonia nitrogen concentration and biochemical oxygen demand may be at very low levels even when coliform counts indicate that water pollution by runoff is occurring. The detection of fecal coliforms by the membrane filter FC test in waters polluted mainly by fecal wastes can be good; 95.2 percent of 733 FC positive colonies from water samples were confirmed as Escherichia IMViC types I or II. (Cartmell-East Central)

2308 - A1 700

### NITROSATION IN FEEDLOT MANURE

P. D. Bergstrom
M. S. Thesis, Department of Microbiology, Colorado State University, 1971, 70 p. 8 fig. 5 tab. 45 ref.

Descriptors: *Waste storage, *Feedlots, *Nitrates, *Amines, Temperature, pH, Nitrates, Chromatography
Identifiers: *Nitrosation

This study was initiated to determine whether conditions permitting nitrosation exist during the normal storage of manure. The findings indicate that nitrites and amines occur in appreciable amounts in feedlot waste. The formation of nitrosamine was detected when the secondary amine concentration was artificially increased. The nitrite content in stored manure was high enough for nitrosamine synthesis, but in the samples examined the secondary amine content appeared to be the limiting factor. Nitrosamines were not detected in stored manure samples that were subjected to high temperature and low pH conditions. Therefore, the rate of nitrosamine synthesis in stored manure is not likely to be rapid enough to permit the accumulation of hazardous amounts of nitrosamine, during the normal storage of feedlot manure. (Cartmell-East Central)

2309 - A5, B1, D1 700

### IDENTIFICATION AND CONTROL OF CATTLE FEEDLOT ODORS

R. S. Narayan
M. S. Thesis, Texas Tech University, Lubbock, Texas, 42 p. 9 fig. 4 tab. 29 ref.

Descriptors: *Odor, *Feedlots, *Cattle, Gases, Chromatography

The primary purpose of the project was to determine the qualitative nature of the gases present in the atmosphere around a beef cattle feedlot in hopes of devising an economically feasible odor control program. Qualitative nature, in terms of functional classification, of the gases present was sought, initially. Specific identification within each factional class was then attempted by gas chromatography. Environmental chamber studies were carried out to study the variation of chamber atmosphere employing different methods of chamber management. During the first phase of chamber management, only a few odiferous contaminants were generated. Among the compounds present, the most obnoxious were acetaldehyde and iso-butraldehyde. When daily washing down of the chamber was discontinued, indole and skatole, which are extremely odiferous, were detected in the chamber atmosphere. The biological degradation of organic matter results in the formation of organic functional groups such as alcohols, carbonyls, amines, esters, etc. Since implementation of a control scheme was not part of the project, no attempts were made to experimentally evaluate the suggested routes for odor control. (Cartmell-East Central)

2310 - B2 700

### A MODEL STUDY OF FLOW VELOCITIES IN AN OXIDATION DITCH

U. Agena
M. S. Thesis, Department of Agricultural Engineering, Iowa State University, Ames, 1968, 100 p. 38 fig. 9 tab. 30 ref.

Descriptors: Model studies, Design
Identifiers: *Oxidation ditch, Flow velocities

A model study of the velocities found in an oxidation ditch was conducted. The effects of changes in rotor speed, paddle finger width, paddle immersion depth, liquid depth, and channel length on the main liquid velocity were investigated. It was found that, providing all other pertinent quantities were held constant, the mean liquid velocity increased as rotor speed increased, as paddle finger width increased, as immersion depth increased, and as liquid decreased. Suggestions for further study were listed. (Cartmell-East Central)

2311 - B1, C2, D4, F1 700

### CHARACTERISTICS AND TREATMENT OF WASTES FROM A CONFINEMENT HOG PRODUCTION UNIT

E. P. Taiganides
Ph. D. Dissertation, Iowa State University, Ames, 1963, 177 p. 31 fig. 14 tab. 44 ref.

Descriptors: *Waste treatment, *Confinement pens, *Chemical properties, *Physical properties, *Anaerobic digestion, Costs
Identifiers: *Swine, *Loading rates, Gas production

The objectives of this study were: (1) to determine qualitatively and quantitatively the physical and chemical characteristics of wastes from a hog confinement production unit, and (2) to evaluate the feasibility of using anaerobic digestion methods for the treatment of said waste prior to ultimate disposal on land. The quantity and composition of manure can be estimated from data on the following factors: the daily quantity and composition of the feed intake the water intake, the size of the hog and the air temperature within the confinement unit. Hog manure is digestible. At 95° F. with once a day feeding and with continuous mixing of the contents of a single stage digester, hog manure could be digested at a loading rate of .2 lb. of volatile solids per day per cubic foot of digester capacity and a detention period of less than 8 days. (Cartmell-East Central)

2312 - A1, E2 700

### FIELD TREATMENT AND DISPOSAL OF LIVESTOCK LAGOON EFFLUENT BY SOIL PERCOLATION

D. H. Vanderholm
M. S. Thesis, Department of Agricultural Engineering, Iowa State University, 1969, 62 p. 12 fig, 19, tab, 43 ref.

Descriptors: *Effluent, *Sprinkler irrigation, Lagoons, Soil profile, Nutrients
Identifiers: Land disposal, Application rates

In a field experiment it was concluded that livestock lagoon effluent can be applied to agricultural land by sprinkler irrigation without creating nuisance problems. Effluent application had no harmful effects under a periodic cover crop. When operated under a periodic loading and recovery schedule, practically no problem of clogging the soil surface or profile is likely. Infiltration rates for lagoon effluent are 20 to 50% lower than for clear water under the same conditions, and application rates should be reduced accordingly. Renovation characteristics of a soil treatment and disposal system are excellent. Some beneficial effect in crop production may be realized due to supplemental irrigation and possible increase in available nutrients. (Cartmell-East Central)

2313 - A1, B1, D1, E1 300

### FEEDLOT MANURE AND OTHER AGRICULTURAL WASTES AS FUTURE MATERIAL AND ENERGY RESOURCES. 1. INTRODUCTION AND LITERATURE REVIEW

Department of Chemical Engineering, Kansas State University, Manhattan, Kansas 66502
W. P. Walawender, L. N. Fan, and L. E. Erickson
Report No. 26 of the Institute for Systems Design and Optimization, Kansas State University, Manhattan, April, 1972, 13 p. 35 ref.

Descriptors: *Feedlots, *Energy, Drying, Incineration, Aerobic treatment, Anaerobic conditions, Fuels
Identifiers: *Waste management, Agricultural wastes, *Manure *Liquefaction, *Gasification, *Hydrogasification, Refeeding, Composting

Recently there has been considerable concern with preserving the environment in terms of air, water and land quality. The conservation of natural resources (both material and energy resources) has also been a topic of concern. The processing of feedlot manure was the object of this study, primarily because of its availability and because of present pollution problems. An introduction to the problem, a review of present feedlot waste management methods and a review of the available technology which may be applicable to the processing of manure is given. Factors complicating utilization of feedlot manure as a fertilizer have brought about alternative management schemes, such as aerobic and anaerobic treatment, incineration, drying, composting, and refeeding. Improved land disposal methods have also been developed. And last but not least, three alternative conversion processes have been developed—liquefaction of manure to produce oil; gasification of manure to produce a synthesis gas; and conversion of manure into methane using a hydrogasification process. There exists a present trend towards the development of the rural areas of our country. Such development will require energy sources which are presently heavily taxed. The resulting products of processing agricultural wastes may thus become a valuable asset to the development of rural areas. (Kehl-East Central)

2314 - B1, D1, E3, F1 700

### FUEL FROM WASTES: A MINOR ENERGY SOURCE

T. H. Maugh II
Science, Vol. 178, No. 4061, p. 599-602, November 10, 1972. 1 tab.

Descriptors: *Fuels, *Organic wastes, *Energy, *Hydrogenation, Methane, Costs, Recycling, Oil
Identifiers: *Pyrolysis, *Bioconversion, Char

Conversion of organic wastes into fuels has developed as a method of possibly easing the energy crisis. The three major methods for such conversion are hydrogenation, pyrolysis, and bioconversion. The hydrogenation process, developed by H. R. Appell and I. Wender of Bureau of Mines' Pittsburgh Energy Research Center, converts as much as 99 percent of the carbon content of organic wastes to oil under optimum conditions. On a pilot scale, problems arose in relation to economic feasibility and technical problems in introducing waste to the reactor under pressure. Garrett Research and Development Company, La Verne, California, concluded that operational costs of pyrolysis or destructive distillation should be lower than for hydrogenation but the problem of collecting and marketing three fuels (gas, oil, and char) produced problems. Bioconversion produces methane at the rate of 10,000 scf for each ton of solid waste and is theoretically a simpler process than hydrogenation or pyrolysis. Problems of this process are: (1) the need for new techniques to feed solids into the digestors, and inexpensive methods for collection and purification of methane, (2) recirculation of the effluents, and (3) control of pollution. Each of the conversion methods are restricted by the limited amount of solid wastes available. A discussion of specific plants employing these recycling methods is included. (Battles-East Central)

2315 - B2, C5 700

### THE STRATIFICATION OF AN ANAEROBIC DAIRY MANURE LAGOON

R. M. Mahan
M. S. Thesis, University of Florida, 1972, 42 p. 15 fig, 33 ref.

Descriptors: *Dairy industry, *Stratification, *Lagoons, *Anaerobic digestion, *Gases, Ammonia, Nitrogen

This study was undertaken to examine the stratification and interrelationships of several factors involved in the degradation processes of an anaerobic dairy manure lagoon. Parameters included: concentrations and species of the various volatile short-chain fatty acids, amount and composition of the evolved gases, and concentration changes of the ammonium bicarbonate buffering system. Short-chain fatty acids had parallel stratification patterns at each depth and the concentration of acetate exceeded those of the other fatty acids. Even though the rates of evolution varied, the composition of the evolved gas was usually consistent. The rate of gas evolution did not directly parallel fluctuation in the short-chain fatty acid pool sizes. Decline in both short-chain acid and the rate of gas evolution effected to degradation occurring within the lagoon. Ammonia-nitrogen was stratified and decreased in concentration during the course of the study. (Cartmell-East Central)

2316 - D2 700

### LIQUID-SOLID SEPARATION OF CATTLE MANURE BY VACUUM FILTRATION

L. F. Backer
M. S. Thesis, Agricultural Engineering Department, North Dakota State University, Fargo, May, 1972. 36 fig, 42 tab, 26 ref.

Descriptors: *Separation techniques, *Filtration, Physical properties, Chemical properties, Biological properties, Dewatering, Cattle.
Identifiers: *Liquid-solid separation, *Vacuum filtration.

The animal waste problem is growing due to our population increase and an increase in the consumption of beef and chickens. Several methods could be utilized for liquid-solid separation of wastes. This thesis is an attempt to investigate the use of vacuum filtration for the liquid-solid separation of manure without preconditioning. Physical, biological, and chemical characteristics of the liquids removed are recorded. The results of the study indicated that: (1) Total and volatile solids content in the filtrate was much greater than the total and volatile solids found in the liquids which drain from the barn at the present time, (2) Cake yield and filtrate yield are generally quite small due to the poor filtering characteristics of manure, (3) The proper vacuum filter size can be determined for a given size operation and for a given set of conditions, (4) Although a significant amount of dewatering was possible, more dewatering would be necessary for further processing. Dewatering capabilities appeared to increase with increasing temperature, (5) Cost of even a small (3 foot diameter x 1 foot width) vacuum filter is quite large (approximately $12,000). Suggestions for further investigations are also given. (Battles-East Central)

2317 - A1, B2, E2 700

### FERTILIZATION VALUE OF CATTLE MANURE IN RELATION TO TREATMENT AND METHOD OF HANDLING

R. F. Hensler
M. S. Thesis, Soil Science Department, Wisconsin University, Madison, 73 p. 20 tab, 45 ref.

Descriptors: *Fertilizers, *Cattle, *Corn, *Liquid wastes
Identifiers: *Application rates, *Manure, Crop yields, pH

A study was made on the effect of type of manure, method of handling, amount of bedding, drying treatment and rate of application on the fertilizing value of cattle manure for corn. Two green house experiments were conducted. One was to determine the effect of fresh, fermented, aerobic liquid and anaerobic liquid dairy cow and steer manures, drying treatment and rate of application on the fertilizing value for corn grown on silt loam. The application of manure increased yields in all cases. The second was conducted to determine the effect of rate of addition of oat straw and wood shavings to fresh, fermented or anaerobic liquid dairy cow manures on their fertilizing value for corn grown on a silt loam. Again the yields of the crops increased by the application of manure in all cases. In a field experiment yields of both ear corn and stover were increased by the application of fresh fermented and anaerobic liquid manures, but the increases were only for the liquid manure placed in bands 4-6 inches from the row. The results of a laboratory experiment indicated that the addition of dilute $H_2SO_4$ to samples of manure to attain a pH of 5.0 or lower prevents loss of N on drying. (Cartmell-East Central)

2318 - B2, D3, D4 700

### THE EFFECTS OF LOADING RATES ON THE DESIGN AND OPERATION OF ANAEROBIC SWINE LAGOONS

Department of Agricultural Engineering
Clemson University, Clemson, South Carolina
H. P. Lynn
M. S. Thesis, Clemson University, Clemson, South Carolina, August, 1968, 73 p. 14 fig, 18 tab.

Descriptors: *Anaerobic lagoons *Design, Biodegradation, Chemical degradation, Biochemical oxygen demand
Identifiers: *Loading rates, Sludge accumulation

The growing of animals to maturity in total confinement has been made possible by agricultural engineers, working closely with animal scientists, poultrymen and other engineers. The handling and disposal of animal wastes has been intensified by the confinement of animal production because of the possible environmental pollution hazards and the cost of disposing of large quantities of high-moisture-content animal waste. The objectives of this study were: 1) to determine the quality of effluent and the effectiveness of a lagoon as a method of swine waste disposal under South Carolina climatic conditions, (2) to determine the effect of loading rate on sludge accumulation, (3) to develop design criteria needed for the satisfactory chemical and biological degradation of swine waste. The loading rates of one market-size hog per 60, 120, 180, and 240-cubic feet of lagoon, replicated four times, were used for the study. Except for occasional overflow during prolonged rainfall, the lagoons had no effluent. The lagoons used anaerobic digestion. The study revealed that the lagoon was an effective method of swine waste disposal, effectively reducing the BOD of untreated swine waste. The loading rate of the lagoons significantly affected the quality of effluent. There was a direct proportion of sludge accumulation to the amount of animal waste added to the lagoons. There was a more pronounced temperature effect on the BOD values for the 60- and 120-cubic-feet lagoons than on the 180-and 240-cubic-feet lagoons because of overloading and higher density of micro-organism population. Suggestions for design criteria are given. Kehl-East Central)

## 2319 - A1, B2, E2 700

### THE MICROBIAL ECOLOGY OF CULTIVATED SOIL RECEIVING COW MANURE WASTE

F. B. Dazzo
MS Thesis. Florida University, Gainesville, 1972, 97 p. 31 fig, 12 tab, 78 ref.

Descriptors: *Farm wastes, *Solids, *Sprinkler irrigation, Rhizosphere, Bacteria, Oats, Sorghum
Identifiers: Microbial ecology, Fecal coliform, Millet

A study was made of the characterization of microbial problems associated with a possible treatment process involving the disposal of dairy waste slurry on land. A sprinkler irrigation system was located at the Dairy Research Unit of the University of Florida. The response of oat, sorghum, and millet to their rhizosphere microorganisms was determined to obtain a base line in toxicity and pathogenesis studies. Data collected showed a decline in the rhizosphere effect on bacteria, actinomycetes, fungi, algae, and on proteolytic, ureolytic, mycolytic, and lipolytic microorganisms. Data indicated that removal of fecal coliforms was most efficient in a soil lysimeter lacking a root system. Irrigating soil with cow manure slurry creates a health hazard since fecal coliforms and Salmonella enteretidis survived longer when introduced into receiving soils than control soils. (Cameron-East Central)

## 2320 - A5, B1, D1, E2, E3 400

### THINK OF MANURE AS A RESOURCE, NOT A WASTE

T. M. McCalla
Feedlot Management, Vol. 14, No. 5, 2 p., May, 1972. 1 fig, 3 tab.

Descriptors: *Water pollution, *Agricultural runoff, *Feedlots, Settling basins, Fertilizers, Mounding, Recycling, Odor
Identifiers: Broad-basin terraces, Land disposal

Pollution of streams and lakes by feedlot runoff is a problem, but technology is available to combat it. If runoff is caught in broad-basin terraces or is allowed to settle out in settling basins, 50 percent or more of the solids will settle out. Reasons for catching these settleable solids are: (1) They contain most of the easily biodegradable material. (2) They reduce retention capacity. (3) If they get into a retention structure, they create anaerobic conditions resulting in foul odors. These solids may be used on the land for crop production or they may be put back on the feedlot for mounding. Mounding serves two purposes: (1) Mounds create an area that drains readily, generally is dry, and offers protection to the cattle from adverse weather conditions; and (2) they act as a compost heap for decomposition on the lot. Besides being used as fertilizer, manure can also be recycled as oil, feed, building materials, and as food for yeast which may be fed to animals. (Merryman-East Central)

## 2321 - A5 700

### QUALITATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR

C. Ifeadi
Ph.D Dissertation, The Ohio State University, Columbus, 1972, 185 p. 45 fig, 27 tab, 110 ref.

Descriptors: *Odor, *Volatility, *Measurement, Diffusion, Gas chromatography
Identifiers: *Dairy wastes, *Dimethyl sulfide, *Diethyl sulfide, Chemical ionization, GC calibration

Odor control is a primary requirement for livestock production in an urban society. A study was undertaken to develop an odor analysis instrumentation for both objective and subjective measurement. The specific objectives of this study were: (1) to develop instrumentation and methodology for quantitative and organaleptic measurement of odor, (2) to measure objectively concentrations of major odor compounds which are released during the decomposition of dairy waste, and (3) to determine organoleptically odor thresholds of dairy wastes. The odor analysis instrumentation was designed, assembled, and operated in the Agricultural Pollution Control Research Laboratory of The Ohio State University. Conclusions were: (1) An adsorbent material, Chromosorb 102, was satisfactorily used to collect volatiles from decomposing dairy waste. (2) The combined use of GC and a chemical ionization mass spectrometer identified and confirmed the presence of dimethyl sulfide and diethyl sulfide, (3) The quantitative measurement of the diethyl and dimethyl sulfide released from stored diluted dairy waste gave an average value of 0.3 ppm for diethyl sulfide and 65.4 ppm for dimethyl sulfide for days that tests were conducted. (4) The sensory evaluation showed that diluted dairy waste had lower odor threshold level than the undiluted waste, and (5) Even though the concentration of dimethyl sulfide was greater than diethyl sulfide, the number of odor units associated with diethyl sulfide was found to be greater than that associated with dimethyl sulfide. (Cameron-East Central)

## 2322 - D4, E2, E3, F1 400

### NEW MANURE CONVERSION PLANT OPENED

Calf News, Vol. 13, No. 6, p. 14, June 1975. 3 fig.

Descriptors: *Recycling, *Fertilizers, *Feeds, *Aerobic digestion, Regulation, Texas, Economics
Identifiers: *Manure

Searle Agriculture's BioCon Division has opened the biggest manure processing plant in the world near United Beef Producers at Summerfield, Texas. This $1,300,000 plant will use an aerobic bacteria digestion process to transform 200,000 tons of manure per year into a soil conditioner or eventually into a feed supplement for cattle. This odorless process kills pathogens and weed seeds, increases nutrient availability, and decreases biological oxygen demand of the product. The firm expects to sell fertilizer and soil conditioner for $20 per ton FOB the plant. Officials of the plant expect regulations to be published very soon concerning use of the product in feed. They do not feel that the regulations will be too tough, but they will require frequent testing. (Merryman-East Central)

## 2323 - D4, E2, E3, E4 300

### OKLAHOMA MANURE FOR MIDWEST METHANE

Environment Midwest, p. 13, December, 1974.

Descriptors: *Methane, *Fuels, *Oklahoma, *Recycling, Cattle, Fertilizers
Identifiers: *Midwest United States, *Biogasification

People's Gas Company recently announced that methane gas generated from cattle manure will provide energy to several Midwest states by mid-1976. Natural Gas Pipeline Company of America has agreed to purchase the methane from Calorific Recovery Anaerobic Process, Inc. of Oklahoma. The gas will be produced through biogasification. It is estimated that the process will use approximately 90,000 tons of cattle manure each year to produce about 640 million cubic feet of methane. A sludge by-product produced in the process will be used as fertilizer which is more environmentally acceptable than raw cattle manure. (Merryman-East Central)

## 2324 - E2 400

### WASTE CONVERSION CONCEPT DEVELOPED

Western Livestock Journal, Vol. 53, No. 30, p. 4, April 21, 1975.

Descriptors: *Recycling, *Aerobic conditions, *Bacteria, *Cattle, Odors, Humus
Identifiers: *Manure, *Soil conditioner

The BioCon Division of Searle Agriculture, Inc., at Summerfield, Texas uses an aerobic bacterial digestion process to transform cattle manure into a product called "Tilleez", which improves the tilth and fertility of soil. The product can be used on farmland without the problems of odor and burning associated with manure. The waste material is first pulverized by a grinder, then distributed in large vats and exposed to air for several days to promote growth of bacteria that converts the waste matter into a humus that can be applied safely to soil. It is estimated the plant will recycle approximately 150,000-200,000 tons of feedlot waste into soil conditioner each year. (Cameron-East Central)

## 2325 - A8, A9, D3 100

### FEEDING OF COUMAPHOS, RONNEL, AND RABON TO DAIRY COWS: LARVICIDAL ACTIVITY AGAINST HOUSE FLIES AND EFFECT ON INSECT FAUNA AND BIODEGRADATION OF FECAL PATS

Agricultural Environmental Quality Institute, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland
R. W. Miller and L. G. Pickens
Journal of Economic Entomology, Vol. 66, No. 5, p. 1075-1076, October 15, 1973

Descriptors: *Insecticides, *Dairy industry, *Feeds, *Larvicides, *Biodegradation
Identifiers: *Coumaphos, *Ronnel, *Rabon, *Fly larvae, Fecal pats, Insect fauna, Musca domestica L.

Results of experiments are reported comparing larvicidal activity against the house fly, the insect fauna of manure pats, and the breakdown of manure from cows fed coumaphos, ronnel, and Rabon. Eight dairy cows were fed a ration consisting of a concentrate mixture fed according to milk production, limited alfalfa hay pellets, and corn silage ad lib. Two of the eight cows served as controls and received no insecticide. The other 6 cows received insecticide supplements — two received coumaphos, two received Rabon, and two received ronnel. Larvicidal activity against Musca domestica L. was significantly greater in feces from cows fed Rabon than in feces from cows fed either coumaphos or ronnel. No residue of coumaphos or Rabon were found in the milk, but significant residues of ronnel were found. Results confirmed earlier experiments, which showed that as a candidate feed-additive larvicide for house fly control, Rabon was superior to either coumpophos or ronnel. Rabon and ronnel did not noticeably effect the biodegradation of pats of bovine feces in a pasture; coumaphos reduced tunneling by insects in the pats, but it did not reduce the amount of dry weight lost. (Cameron-East Central)

2326 - B3, D4 300

## INDOOR LAGOON FOR POULTRY MANURE DISPOSAL

Assistant Professor of Poultry Husbandry,
Nebraska Agricultural Experiment Station,
University of Nebraska, Lincoln
W. J. Owings and J. L. Adams
Nebraska Experiment Station Quarterly, p. 16-17, Summer, 1961.

Descriptors: *Poultry, *Waste disposal, *Waste treatment, *Lagoons, Aerobic bacteria, Anaerobic bacteria

Because the trend in the poultry industry today is toward large mechanized laying houses, disposal of manure has become a major problem. Because farmers generally prefer to buy a more concentrated commercial product for fertilizer and because many large poultry operators do not own enough land to efficiently dispose of the manure themselves, new alternatives must be found. The Poultry Department of the University of Nebraska is experimenting with an indoor lagoon which utilizes the intestinal bacteria of the bird to decompose the manure. A control pen has been set up which has a litter floor covered with wood shavings. The experimental pen has a full slat floor with a water-tight pit containing 630 cubic feet of water underneath it. 180 birds were housed in each pen as of October 15,1960. During the six months tested, egg production in the experimental pen has been about 4 percent higher than the control pen. The lagoon kept the experimental pen warmer during the winter. While the experimental pen has been operating very well, more information is needed concerning how much water is needed per bird and the proper temperature necessary to support adequate decomposition of the manure. (Merryman-East Central)

2327 - A9, B1, C4 100

## PERSISTENCE OF SALMONELLAE IN POULTRY EXCRETA

Department of Environmental Science,
Rutgers University, New Brunswick, New Jersey
J. H. Berkowitz, D. J. Kraft, and M. S. Finstein
Journal of Environmental Quality, Vol. 3, No. 2, p. 158-161, April-June, 1974.

Descriptors: *Poultry, *Salmonella, *Waste storage, *Storage requirements, Temperature
Identifiers: *Waste management

Precautions should be taken against the introduction of viable pathogenic microorganisms into the environment in the management of poultry wastes. Nontyphoid salmonellae are of special concern as they are pathogenic bacteria which affect humans and are commonly excreted by apparently healthy poultry. The object of this study is to observe the survival of salmonellae under conditions simulating storage in cage type poultry operations. A survey of commercial farms showed a range (for samples positive for Salmonella) in freshly voided specimens of from less than 1 to almost 35,000/g dry weight. The high value roughly corresponds to 7,000/g wet excreta. It would seem advisable to base storage guidelines on the higher end of this range to provide a wide margin of safety. As judged by a specific most-probable-number procedure, Salmonellae inoculated into samples of poultry excreta declined to very low numbers or disappeared within a month. However, the decline was usually preceded by a period of growth. This study provides a basis for estimating the length of time wet poultry excreta should be stored to insure acceptable Salmonellae densities, at temperatures representative of field conditions. An effective means of killing salmonellae is storage of undried excreta. (Kehl-East Central)

2328 - D1, E3 100

## THE OIL CONVERSION PROCESS: AN ASSESSMENT

Agricultural Engineering, Vol. 53, No. 3, p. 20, March 1972.

Descriptors: *Recycling, *Oil, Livestock
Identifiers: *Agricultural wastes, *Conversion, Manure

S. S. De Forest reports on his visit to the Pittsburgh Energy Research Center, where the conversion of livestock manure and other agricultural wastes to low sulfur oil has become a reality. The scientists from the Research Lab suggest that the chemistry is basically simple; a process similar to the one used to convert coal to oil. Preliminary work suggests that the yield of oil is 40-50 percent or 3 barrels per ton of dry manure, the highest yield of any of the materials examined. De Forest feels that conversion plants for converting animal wastes to oil would be located to utilize cellulosic materials other than livestock wastes, ensuring that an economical supply of raw materials will continuously be available. The concept of converting livestock wastes to oil will require vast concentrations of livestock. This creates new problems in handling and managing vast numbers of animals and the products associated with them, such as feed, water and manure. (Cameron-East Central)

2329 - D1, E3 100

## CONVERTING ORGANIC WASTES TO OIL

Pittsburgh Energy Research Center,
U.S. Bureau of Mines,
Pittsburgh, Pennsylvania
H. R. Appell
Agricultural Engineering, Vol. 53, No. 3, p. 17-19, March, 1972. 2 fig. 1 tab.

Descriptors: *Recycling, *Organic wastes, *Oil, Cellulose, Cattle, Chemical properties
Identifiers: *Conversion, *Agricultural wastes, Carbon monoxide

The Bureau of Mines has successfully converted agricultural wastes, bovine manure, wood, urban refuse and sewage sludge to a low-sulfur fuel oil. The method requires reaction with carbon monoxide and water at temperatures of 300 degrees to 400 degrees C and pressures of 3000 to 4000 psig. Batch experiments on converting organic solid wastes to oil usually consist of placing the waste material in an autoclave, adding water and catalyst (if not present in the waste) and then adding carbon monoxide to the desired pressure. A continuous bench-scale unit to achieve this reaction is now in operation. The product from these continuous runs is a brownish-black oil at room temperature. Mass, infrared and ultravoilet spectrometric examination of the oil produced at 350 degrees C and 4000 psig indicates that the oil is mostly aliphatic with either linkages and carbonyl and hydroxyl groups present. Much of the material appears to exist in cyclic structures (Cameron-East Central)

2330 - E1 400

## BRITISH GROUP ENCOURAGING WASTE RECYCLING

Feedstuffs, Vol. 47, No. 22, p. 32-33, June 2, 1975.

Descriptors: *Recycling, *Farm wastes, *Great Britain, Energy, Proteins
Identifiers: *Agricultural Wastes Processors Association, *Livestock wastes, Processing

The Agricultural Waste Processors Association encourages the processing, recycling, and recovery of all kinds of agricultural waste materials, including livestock manures, green vegetable waste and straw throughout the world. Animal wastes provide sources of energy, protein, phosphorous, copper and various other trace elements which are becoming increasingly scarce and expensive. Expressing views concerning processed wastes to the legislature, public and other associations is probably the main objective of the AWPA. AWPA hopes to encompass all persons and organizations interested in aspects of farm waste processing throughout the world. To keep those interested individuals in touch with developments and new applications for processed wastes, the association publishes a regular publication known as "The Waster." Anyone living in the U. S. interested in the recycling of wastes and in AWPA should contact the national secretary. (Cameron-East Central)

2331 - B1, C2, C3, E2 300

## NUTRIENT AND ENERGY COMPOSITION OF BEEF CATTLE FEEDLOT WASTE FRACTIONS

Agricultural Experiment Station,
Nebraska University, Lincoln
C. B. Gilbertson, J. A. Nienaber, J. R. Ellis, T. M. McCalla, T. J. Klopfenstein, and S. D. Farlin
Nebraska Agricultural Experiment Station Research Bulletin 262, July, 1974, 29 p. 2 fig. 10 tab, 77 ref.

Descriptors: *Nutrients, *Energy, *Cattle, *Feedlots, Nebraska
Identifiers: *Ration roughage

This bulletin describes nutrient and energy composition of beef cattle waste fractions as a function of the ration roughage level and type of feedlot. High- medium-, and low-roughage ration feces (HR, MR, LR) were collected from animals fed in metabolism crates. Thymal was mixed with these feces to prevent decomposition and mold growth. Samples were obtained from housed feedlot and outdoor feedlot cattle fed at the University of Nebraska Field Laboratory. Total solids content averaged 26.7 percent wb for high and low roughage ration feces, 19.3 percent wb for medium roughage ration feces, and 21.7 and 45.2 percent wb for manure from housed and outdoor feedlots, respectively. Volatile solids were 86.9 percent, 89.4 percent, and 93.9 percent db for feces from cattle fed high, medium, and low roughage rations. Manure from housed and outdoor feedlots were 85.8 percent and 24.0 percent volatile, respectively. The quantity of feces solids retained on sieves greater than 400 microns increased with decreased ration roughage content while those retained on sieves smaller than 400 microns decreased with ration roughage content. The ration fed did not significantly affect the gross energy of manure fractions or protein and fat contents of feces solid fractions. Nitrogen content increased with decreased ration roughage level and ranged from 0.61 to 4.75 percent. The ration roughage level did not have a predictable effect on the element concentration of the solids. (Cartmell-East Central)

2332 - A5 100

## ODOR SENSATION THEORY AND PHENOMENA AND THEIR EFFECT ON OLFACTORY MEASUREMENTS

Associate Professor, Agricultural Engineering Department, Clemson University, Clemson, South Carolina
C. L. Barth
Transactions of the ASAE, Vol. 16, No. 2, p. 340-347, March-April, 1973. 5 fig. 1 tab, 45 ref.

Descriptors: *Odor, *Measurement, Temperature
Identifiers: Manure, Adaptation, Fatigue, Dilution, Gas-liquid chromatography

It was the purpose of this report to bring attention to procedures that might be employed for specific odor determinations and to highlight phenomena important in analysis of odor quality and intensity. A complete description is given of the human olfactory mechanism. Different theories of odor perception are discussed. Accurate characterization of an odor includes reference to its strength of intensity, and its quality. There is no commonly accepted stand — no point of reference — from which to judge odor quality. Limitations of odor testing result from the existence of the odor phenomena and the preferences of the observer. Adaptation is the adjustment to the odor stimulus and fatigue is the result of adaptation. Changes in odor quality sometimes occur due to dilution. The recommended temperature for odor testing is 40 degrees C. Mixtures, drugs, chemical reactions, contamination, the age, sex and smoking habits of the judge, natural variation and uncertainty are all factors that can enter into olfactory measurements. The gas-liquid chromatograph has been the most important instrument in supplementing the capabilities of the human nose in odor research. (Cartmell-East Central)

### 2333 - A1 100

### PHENOLIC ACIDS AS INDICATORS OF POLLUTION WITH LIQUID MANURE. A METHOD FOR THEIR DETECTION

Fishery Laboratory of the Agency of Environmental Protection, Charlottenlund, Denmark
O. Rump
Water Research, Vol. 8, p. 889-894, 1974, 3 tab, 8 ref.

Descriptors: *Pollutant identification, *Water pollution
Identifiers: *Phenolic acids, *Pollution indicators, *Liquid manure

This investigation is concerned with the development of a method to detect illegal liquid manure discharges. The method can be used to measure or detect water pollution. The investigation falls into two parts: 1. To find substances which are suitable indicators of liquid manure. 2. To develop an analytical method for the detection of such substances and test its application. M-hydroxybenzoic acid, m-hydroxyphenylacetic acid and m-hydroxyphenylpropionic acid in liquid manure occur in considerable quantities. They provide a sensitive analytical method for detecting liquid manure, even where this has been diluted considerably. A method for the detection of liquid manure is thin-layer chromatography on cellulose. The developed chromatograms are rendered visible by spraying with diazotized p-nitroaniline. By this method the minimum detectable amounts of the phenolic acids are approximately 0.01 ug. (Cartmell-East Central)

### 2334 - A1, E2 400

### ORGANIC WASTE: ONCE NUISANCES, NOW RESOURCES

G. Sollenberger
The Furrow, p. 2-5, April 1975, 8 fig.

Descriptors: *Organic wastes, *Fertilizers, *Soil amendments, Reclamation, Nutrients, Costs, Erosion control
Identifiers: Application rates, Manure

The major problem with manure used to be how to get rid of it, but now it is how to get enough of it. The high prices and tight supplies of commercial fertilizers have made manure a much sought after fertilizer. The nutrient content of manure varies with age and ration of the livestock, the species of livestock and with how the manure is stored and handled. Doubtful farmers who once questioned the worth of hauling manure now discover they can use it to reduce production costs — and not by piddling amounts. An example is given. Researchers discovered in USDA studies at Manhattan, Kansas that animal waste was about as effective as anchored straw in slowing soil loss from a highly erosive sandy soil. Reclamation by building up non-productive land with sewage sludge has also been found effective in amending soils. The possibility of using some industrial organic wastes as a soil amendment is being examined as well. Use of organic wastes as fertilizers and soil amendments does have its problems. New pollution laws call for more intensive control of flies, odors and runoff. Application rates must be determined so that the manure will increase instead of decrease crop growth. Careful management is also needed in preserving the nutrients in manure. Finally, the problem of variability in the nutrient content of many wastes calls for additional attention. (Kehl-East Central)

### 2335 - A1, B1, F2 300

### ENVIRONMENTAL PROTECTION GUIDELINES FOR DAIRIES

Agricultural Engineer, Texas Agricultural Extension Service, Texas A&M University, College Station
J. M. Sweeten
Mimeograph Publication, Texas Agricultural Extension Service, Texas A&M University, March 14, 1975, 7 fig.

Descriptors: *Legal aspects, *Regulation, *Dairy industry, *Waste management, *Texas, Permits, Water pollution control, Air pollution control
Identifiers: Runoff control, Sanitation

Proper site selection and facility design can minimize the water and air pollution from dairies. State and federal pollution control regulations greatly influence the design of dairy waste management systems. Such requirements for Texas dairies are given and explained. The major requirement for dairies to obtain permits from the Texas Water Quality Board is that systems be provided to prevent discharge from the premises. Generally, two systems are required: runoff control and manure management. Recommendations for these systems are given. Federal water pollution control regulations are also discussed. The Texas Air Control Board under the State Air Pollution Control Program has the authority to regulate odors from all dairies in the State under a general nuisance regulation. Permits and other regulations are required by the Texas Air Control Board and are explained. Dairy sanitation is under the Texas State Department of Health and milk inspection units of major Texas cities. Requirements for sanitation are listed. General Permit Procedures are discussed. (Kehl-East Central)

### 2336 - A5, B2, C5, D4 400

### MUNICIPAL SLUDGE IN SWINE MANURE HELPS CONTROL ODORS

J. L. Roll, D. L. Day, and B. A. Jones, Jr.
Illinois Research, Vol. 16, No. 2, p. 14, 1974, 1 fig.

Descriptors: *Waste treatment, *Odor control, *Anaerobic digestion, Chemical oxygen demand, Degradation
Identifiers: *Swine, *Municipal sludge

A study was conducted to determine whether the addition of fresh non-lagooned municipal digester sludge to liquid swine manure would help initiate anaerobic activity and control odors. Three trials were conducted, utilizing five digesters in each trial. Trials 1 and 2 were batch digester tests, with digesters being loaded and allowed to run two weeks without addition or removal of material. Trial 3 was a 45-day study in which 1 liter of digester contents was removed each day and 1 liter of new material was added. In all trials, the five digesters contained the following ratios (on a volume basis) of liquid swine manure to municipal digester sludge: 2:1, 1:1, 1:2, 1:5, and 1:10. Anaerobic digestion was excellent in all trials. Digesters with 2:1 and 1:1 manure to sludge exhibited the best chemical oxygen demand and volatile solids reduction. A "sniffing" panel found the digester with 1:5 manure to sludge to have the least offensive odor. The digester sludge was valuable in establishing good anaerobic activity in manure. Consequently, manure was more rapidly degraded and odor was controlled. However, the best degradation was observed in the digester with the most odor. Some odor may have to be tolerated in order to achieve good optional reduction. (Merryman-East Central)

### 2337 - B1, D1, E2 400

### MANURE GETS RE-DISCOVERED

J. Goldstein
Compost Science, Vol. 15, No. 2, p. 24-27, March-April, 1974.

Descriptors: *Feedlots, *Fertilizers, *Livestock, *Costs, Energy, Nitrates, Dairy industry, Recycling
Identifiers: *Manure, *Land disposal

Several publications are listed which comment on the fertilizer shortages, antipollution laws, and the economics and methods for using manure. The fertilizer shortage may solve one major problem — economically disposing of large amounts of manure that accumulate at livestock markets. The best way to handle manure at the markets is to dehydrate it first. The dried product can be produced for just a few cents a pound. Farmers are now buying the raw manure to use in place of the nitrogen and phosphate they are finding hard to get. Just about any good commercial farmer who raises livestock as part of a mixed farming program returns manure to the land. Using the natural fertilizer produces a more iron-rich crop, compared to chemical fertilizers. (Cartmell-East Central)

### 2338 - B1, E2 400

### FOR THE SAKE OF YOUR NEIGHBORS—SLURRY INJECTION

London
A. Collier
Power Farming and Better Farming Digest, p. 21, 23, September, 1973, 3 fig.

Descriptors: *Slurries, *Equipment, *Costs
Identifiers: *Land disposal, *Soil injection

Researchers at Wageningen, Holland have developed a self-propelled tanker injector for control of the waste disposal problem. The machine is based on a Massey Ferguson 17" tractor. It provides a fast, effective, and low odor technique by use of a tanker with rear-fitted soil tines which slit the soil for injector tubes to place the slurry. A chopper pump takes the material from the tanker and makes lumps and fiber pass through tubes and injectors without blocking thus allowing working rates up to 40 tons an acre to depths of 12 inches. (Battles-East Central)

### 2339 - A4, B1 300

### GROUND WATER POLLUTION PROBLEMS IN THE NORTHWESTERN UNITED STATES

Geraghty & Miller, Inc.
Port Washington, New York
Frits van der Leeden, L. A. Cerrillo, and D. W. Miller
Environmental Protection Agency Report No. EPA-3-75-018, 361 p. 60 fig. 48 tab, 176 ref.

Descriptors: *Ground water, Mine wastes, Salinity, Septic tanks, Water pollution, Water quality, Water resources, Waste dumps, Wells, Feedlots, Agricultural runoff, Northwestern United States, Colorado, Idaho, Montana, Oregon, Washington, Wyoming

An evaluation of ground-water pollution problems has been carried out in six states in the northwest: Colorado, Idaho, Montana, Oregon, Washington and Wyoming. The findings of the investigation indicate that, with the exception of radioactive waste disposal, few cases of ground-water pollution have been investigated in detail. There is a need for baseline water-quality data and systematic evaluation of overall ground-water conditions, especially in urban zones, in areas of petroleum exploration and development, and at locations of mining and industrial activity. The most common natural ground-water quality problems, other than high salinity, are excessive hardness, iron, manganese, and fluoride. Principal sources of man-caused ground-water quality problems in the approximate order of severity are: discharge of effluent from septic tanks and sewage treatment plants, irrigation return flow, dryland farming, abandoned oil wells, shallow disposal wells, unlined surface impoundments, mine tailings and mine drainage, municipal and industrial landfills, and radioactive waste disposal. Other sources that appear to be of less importance but still must be considered include: spills and leaks, application of fertilizers and pesticides, feedlots, and salt-water intrusion. (Scalf-R. S. Kerr Environmental Research Laboratory)

2340 - A1, E2 100

### RESULTS FROM EXPERIMENTS MEASURING THE EFFECTS OF LARGE AMOUNTS OF FERTILIZER AND OF FARMYARD MANURE ON MAINCROP POTATOES GROWN IN SANDY SOIL AT WOBURN, BEDFORDSHIRE

**Rothansted Experimental Station,
Harpenden, Herts
F. V. Widdowson, A. Penny, and R. C. Flint
Journal of Agricultural Science, Vol. 82, Pt. 1, p. 117-128, February, 1974. 2 fig, 12 tab, 7 ref. ref.**

**Descriptors: *Fertilizers, *Crop production, Nitrogen, Potassium, Phosphorus, Great Britain
Identifiers: *Manure, *Yields, Land disposal**

By using both farmyard manure (FYM) and fertilizers, rather than fertilizers alone, the largest yields of potatoes were obtained in the Woburn Reference Experiment. The objective of this study was to find an explanation of this in experiments made on the coarse sandy loam found in Woburn. Four experiments were conducted during the period of 1968-1971 on Stackyard Field at Woburn, Beds. The soil was an acid sandy-loam overlying Lower Greensand. The study showed that FYM was less effective than fertilizer when given alone. The combination of fertilizer and FYM gave a larger yield than the double amount of fertilizer incorporated shallowly or a single amount of fertilizer. However, a smaller yield was obtained with the combination than with the double amount of fertilizer incorporated deeply, which gave the largest yield each year. In order to construct nutrient balance sheets, the NPK contents of the potato tubers were used. The balance sheets showed that large residues of N, P and K remained in the soil after harvest. FYM residues increased yields of both grain and straw while fertilizer residues increased only straw yields. When compared to freshly applied N, both kinds of residues were less effective, so most of the N leached during winter. The study also indicated that the yield of saleable tubers was increased by the double amount of fertilizer. (Kehl-East Central)

2341 - B1 400

### MOST FLUME FLOORS SHORT ON ENGINEERING

**Beef, Vol. 11, No. 9, p. 6-7, May, 1975. 4 fig. 1 tab.**

**Descriptors: *Safety factor, Flow rate, Waste dilution, Volume
Identifiers: *Flume floors, *Gutter design guidelines, Lagoon pumping**

At a Cattle Feeders Seminar in Columbia, Missouri, the engineering of flume floor systems was examined. Bob George, University of Missouri agricultural engineer, claims that some of the flush-type buildings he has seen operate on the "brink of disaster". He states that most current flume-type floors just don't have a large enough safety factor designed into the flumes. Two Missouri feeders, Lewis Wilson and Ed Gunnels discussed their systems and admitted that although they're not the safest, they do the job. A table containing recommendations for gutter design dimensions is provided and is based on gutters eight inches wide. Mr. George also gave a few recommendations about the lagoons hooked onto flushing systems. These are listed, and are applicable primarily to Central Missouri. (Kehl-East Central)

2342 - A9, B2, C5, D4, E3 100

### RECYCLING SWINE WASTE AS FEED

**Department of Animal Science,
Illinois University, Urbana
B. G. Harmon and D. L. Day
Illinois Research, Vol. 15, No. 3, p. 14-15, Summer, 1973. 2 fig, 6 tab.**

**Descriptors: *Recycling, Proteins, Amino acids, Health
Identifiers: *Refeeding, *Swine, *Oxidation ditch mixed liquor (ODML)**

About 300 hogs have been fed in oxidation ditch mixed liquor (ODML) studies over the past three years in an attempt to minimize pollution and to take advantage of the protein and amino acids that ODML has to offer. Representative samples of all the hogs have been slaughtered and inspected for liver or lymphatic tissue changes. No changes attributable to the feeding of ODML have been found in the slaughtered animals. All carcasses have passed meat inspection. Actual descriptions of the studies are given. (Merryman-East Central)

2343 - A9, E3 400

### AG ENGINEERS REVIEW NEW WASTE MANAGEMENT SYSTEMS

**Feedstuffs, Vol. 47, No. 17, p. 6, 74, April 25, 1975.**

**Descriptors: *Poultry, *Nutrients, Additives, Health
Identifiers: *Refeeding, Dehydrated poultry waste**

At the American Society of Agricultural Engineer's Symposium on Livestock Wastes, held at the University of Illinois, the management of poultry and livestock wastes was examined from an agricultural engineer's viewpoint. A demonstration project at the Michigan State University was described by Dr. M. L. Esmay of MSU as an attempt to obtain design and management information for the optimum handling of wastes from a commercial-sized cage-type layer house. The objective of the program was to study the management of poultry excreta in a closed environmental ecological system including the production of dehydrated poultry waste (DPW) for feeding, odor abatement and pollution control. From the study, several significant results were noted and listed by Dr. Esmay. Dr. Robert G. Yeck of the U. S. Department of Agriculture's Agricultural Research Service discussed the existing opinions and potentials for using nutrients from animal wastes in feed. Dr. Yeck stated that there are potential adverse effects from feed additives and inadvertent contaminants that must be recognized. He also listed the constraints to implementation of the various systems. These are: animal acceptability, utility, animal product safety and consumer acceptance. R. D. Glock and K. J. Schwartz of Iowa State University said that the design of these facilities should include consideration of the potential disease hazard. (Kehl-East Central)

2344 - B1, E3 400

### SEPARATING SOLID WASTE FROM LIQUID

**Managing Editor, Feedlot Management
G. Ashfield
Feedlot Management, Vol. 17, No. 5, p. 6-8, May, 1975. 3 fig.**

**Descriptors: *Solid wastes, *Liquid wastes, *Cattle, *Recycling, Feeding rates
Identifiers: *Separation, *Refeeding, Confinement housing**

At the Kissinger integrated cattle operation near Fairfield, Nebraska, 60-70 tons of manure, produced by steers housed in their 1,110 head slope-slat, flush barn, are retrieved and recycled into dried waste material which will be put to use as one of the ingredients in dry cow ration. The recycled wastes are mixed with stalklage from the cropping program at a ration of 4:3. The 60-70 tons of solid waste is screened from the liquid produced in the Kissingers' cold confinement barn. The Kissingers run cows in two herds of approximately 300 cows each for spring and fall calving in a semi-confined, drylot area. This lends itself well to feeding to the nutritional requirements of the various stages of the yearly cow cycle, artificial insemination and overall management of the cow herd. (Cameron-East Central)

2345 - A9, E3 400

### RECYCLING NUTRIENTS FOR LIVESTOCK

**Animal Science Department, Mississippi State University, Mississippi State, Mississippi
H. W. Essig
Feedstuffs, Vol. 47, No. 21, p. 35, 43, May 26, 1975. 19 ref.**

**Descriptors: *Recycling, *Poultry, *Regulation, *California, *Mississippi
Identifiers: *Refeeding, *Dried poultry waste, *Food and Drug Administration, *Health**

Scarcity of land for manure disposal and concentration in poultry production are causing waste disposal problems. Methods other than land disposal are needed. Many poultry producers are turning to recycling dried poultry wastes as feed. Dried poultry waste appears to be the waste material that has the greatest potential as a feedstuff because it is high in crude protein, normal in minerals and negative to aflatoxins and salmonella. The states of California and Mississippi have moved ahead independently in sanctioning the use of dried poultry waste (DPW) in feedstuffs. The Food and Drug Administration is in the process of restating its position on the use of recycled nutrients in livestock feeds, and these regulations should be published in the near future. Before recycled nutrients from poultry operations can be used as a feedstuff, state and FDA regulations must be set forth to insure a standardized product that is not harmful when fed to animals. The poultry producers must make an effort to control the quantities of copper, arsenic, selenium and other heavy metals, as well as any drugs that might appear in the recycled nutrient materials. (Merryman-East Central)

2346 - A1, B1, E2 400

### CONSEQUENCES OF WASTE DISPOSAL ON LAND

**Research Soil Scientist, Agricultural Research Service, USDA, Professor of Soils at the University of Minnesota
W. E. Larson, J. R. Gilley, and D. R. Linden
Journal of Soil & Water Conservation, Vol. 30, No. 2, p. 68-71, March-April, 1975. 1 fig, 4 tab, 22 ref.**

**Descriptors: *Waste disposal, *Organic wastes, *Sewage sludge, *Sewage effluents, Reclamation, Productivity, Crop response, Wind erosion
Identifiers: *Land disposal, *Manure, Pollution**

Organic wastes can be used safely and effectively to increase soil productivity if proper precautions are taken concerning heavy metals, toxic chemicals, nitrate leaching, erosion losses, and undesirable odors. Average composition is given for animal wastes (dairy cattle, beef cattle, swine and poultry hens), sewage sludge and secondary sewage effluent. Farm manures contain the major nutrients in the most correct proportion for soil fertilization. They also decrease bulk density, increase aggregate stability, increase water intake rates, and help control soil erosion. Sewage sludges have proved effective in reclaiming such productive land as mine spoil banks, wastes from a soda glass factory, dune and dredged sands, and abandoned garbage dumps and sanitary land fills. There is also evidence that crop yield increases as the result of irrigation with treated municipal wastewater. It must be emphasized that proper waste management measures must be taken to protect the environment. When applied at crop use rates and with proper soil management, most organic wastes present no serious environmental hazards and should be considered a resource that agriculture can very well use. (Merryman-East Central)

2347 - A3 200

### CONCENTRATIONS AND CYCLES OF BACTERIAL INDICATORS IN FARM SURFACE RUNOFF

**Research Hydrologist, Agricultural Research Service, U.S. Department of Agriculture
S. H. Kunkle
In "Relationship of Agriculture to Soil and**

Water Pollution," Cornell University Conference on Agricultural Waste Management, Rochester, New York, 1970, p. 49-60. 7 fig, 2 tab, 27 ref.

Descriptors: *Water pollution, *Agricultural runoff, *Coliforms, *Animal wastes
Identifiers: *Bacterial indicators, *Feces

Adequate surveillance techniques for detecting animal waste contamination of streams are essential if water pollution is to be avoided. This report describes initial results from a study of bacterial pollution indicators on the Sleepers River Watershed, Danville, Vermont. During periods of storm runoff from the watershed concentration of total and fecal coliforms rose drastically, with distribution of the values closely related to the hydrograph. Total coliform concentrations in runoff from the hayfield (unsubjected to farm animal wastes) were similar to concentration in runoff from the partially grazed 0.75 sq km watershed, making use of total coliform data of questionable value for pollution surveillance within the rural watershed. To the contrary, the fecal coliform densities were much greater in the partially grazed watershed's runoff than in the hayfield's. Evidently the more specific coliform group is a much better pollution indicator for the conditions of the study. The percentage of total coliforms that were fecal types was much higher in the watershed runoff than in the hayfield runoff. This study emphasizes that the hydrologic processes are of extreme importance in reference to use of indicator organisms. These hydrologic and physical relationships need to be well described if water quality inputs in streams are to be successfully modeled. (Cartmell-East Central)

2348 - D3, E3 100

### ULTIMATE IN RECYCLING

Chemical Week, Vol. 113, No. 12, p. 16, September 19, 1973.

Descriptors: *Recycling, *Feeds, *Reclamation, Economics, Feedlots, Chemicals, Colorado, Cattle
Identifiers: *Refeeding

This article discusses a 200-head pilot project to feed steers recycled manure begun recently by Ceres Land, Sterling, Colorado, a major cattle feeding company. The company expects to have the system in "full commercial operation" by January 1, 1974, and intends to sign joint venture agreements with feed lots. One of the developers of the process estimates that the feed will cost less than one-third the price of conventional materials and that the technique poses no pollution problems, leaving only residues of clean-water vapor and five percent ash. The recycling process is described. Although the process is expected to require large amounts of chemicals, the manufacturers of cattle feed additives and the producers' trade associations do not see any major effect on sales of their products. (Solid Waste Information Retrieval System)

2349 - E3 400

### RECYCLING POULTRY LITTER AS SILAGE

C. R. Creger
Poultry Digest, Vol. 34, No. 400, p. 256, June, 1975.

Descriptors: *Recycling, *Silage, *Cattle, Weight, Taste
Identifiers: *Poultry litter, Broiler litter

Early results from a Texas A&M University program of recycling poultry litter as silage for beef cattle are favorable. Each of four groups of birds was fed a standard broiler diet containing 19-24 percent protein for 8 weeks. Water was added until the total moisture content was 35-38 percent. Fifteen heifer calves, each weighing about 477 pounds, were placed on a feeding regimen that consisted of broiler litter silage free-choice. Eight pounds per head of a 12 percent protein mixture were poured over the silage daily. Results of the tests showed the calves gained an average of 2.54 lbs per head per day when fed the broiler litter silage free-choice, along with the 12 percent protein mix for a period of 120 days. A trace mineral analysis indicated the silage was an excellent source of calcium, phosphorus, and other trace elements. A 50 member panel detected a small but significant difference in taste between steak from the treated and nontreated animals. All steaks received acceptable scores in taste, but the panel expressed a preference for steak from nontreated control. (Cameron-East Central)

2350 - E3, F1 400

### CATFISH ON DPW

Poultry Digest, Vol. 34, No. 398 (4), p. 30, April, 1975.

Descriptors: *Catfishes, *Diets, *Performance, *Taste, Costs
Identifiers: *Dried poultry waste

An experiment was conducted to study the effects of feeding dried poultry waste to catfish. Each of three ponds were stocked with 150 channel catfish fingerlings. Pond 1, which was fed a control diet containing fish meal and poultry by-product meal as sources of animal protein, had 136 fish at harvest. Average gain was 0.51 pound from the initial stocking rate of 0.25 pound. Pond 2, which was fed a diet containing 25 percent air-dried poultry waste and sources of animal protein, had 139 survivors. Average gain was 0.67 pound from an initial weight of 0.20 pound. Pond 3 was fed a diet containing 25 percent air-dried poultry waste and no source of animal protein. There were 139 survivors, and the average gain was 0.67 pound from an initial weight of 0.20 pound Cost of the ration was reduced approximately $24 to $30 by substitution of dried poultry waste for animal protein ingredients. A higher percentage of the taste panel expressed a dislike for the catfish receiving the control ration which contained no air-dried poultry manure. (Merryman-East Central)

2351 - B1, E1 100

### EXPERIMENTAL FACILITIES FOR STUDIES ON BEEF HOUSING AND EQUIPMENT

Department of Agricultural Engineering,
North Dakota State University, Fargo
R. L. Witz and G. L. Pratt
Canadian Agricultural Engineering, Vol. 13, No. 2, p. 81-84, December, 1971. 9 fig, 4 tab, 4 ref.

Descriptors: *Confinement pens, *Cattle, *Design, *Waste disposal, *Waste storage, *Equipment. Slotted floors, Ventilation, Liquid wastes, Solid wastes, Lagoons
Identifiers: *Waste management, Land disposal

Studies were conducted to develop improved feed handling systems, manure disposal facilities, and ventilation equipment for beef confinement housing. To study these problems, a test facility was built in which two units, each capable of holding a block of 20 feeder calves, were incorporated. The design of the west half of the facility had a sloping concrete floor installed in a shallow pit below a slotted floor. The liquids were drained south in the direction of the slope and were pumped to a lagoon. The solids were scraped north with a cable-scraper and conveyed out of the building at frequent intervals. The ventilating system utilized double fans, using a fan and heat sink on both the intake and exhaust. The design of the east half of the facility was a conventional system using a slotted floor with a deep-pit manure storage. Manure was removed in a slurry form on a semi-annual basis and spread on farm fields. The ventilating system was patterned after one commonly used in greenhouses and continually circulated the air to maintain uniform temperature. (Cartmell-East Central)

2352 - A1, E2 100

### DAIRY CATTLE MANURE — IT'S EFFECT ON RYE AND MILLET FORAGE YIELD AND QUALITY

USDA, Auburn University Agricultural Experiment Station, Auburn, Alabama
A. F. Lund, B. D. Doss and F. E. Lowry
Journal of Environmental Quality, Vol. 4, No. 2, p. 195-198, March-April, 1975. 7 fig, 2 tab, 9 ref.

Descriptors: *Dairy industry, *Waste disposal, *Crop response, *Soils, Nitrogen, Nitrates
Identifiers: *Land application, *Application rates, *Dothan loamy sand, *Lucedale sandy loam, *Rye, *Millet

A study was conducted to evaluate the effects of various rates of manure applications on forage yield and quality of rye and millet, double-cropped on two different soils—Dothan loamy sand at Auburn, Alabama and Lucedale sandy loam at Thorsby, Alabama. In general millet and rye on both types of soils produced good forage with rates of dairy cattle manure of 22.5 and 45 metric tons/ha incorporated into the soil. Organic nitrogen increased as manure application rate increased up to the 180 metric tons/ha rate on Lucedale soil. Nitrogen content was higher for rye than for millet for a given treatment and soil, and tended to be higher on Dothan than on Lucedale for any one treatment and crop. Nitrate content was also higher on Dothan than on Lucedale. Both millet and rye had nitrate contents above 2 percent when 180 and 270 metric tons/ha of manure were applied. Most treatments produced tetany-prone forage that contained K/(Ca + Mg.) ration above 2.2. The forage produced with high rates of manure on Lucedale soil had higher K/(Ca + Mg) ratios than did that of Dothan soil with equal rates of manure application. $NO_3$ was higher in the forage of the Dothan soil when high rates of manure were used. (Cartmell-East Central)

2353 - B1, E2 400

### POULTRY LITTER'S VALUE AS FARTILIZER CITED BY GEORGIAN

Feedstuffs Southeastern Correspondent
R. H. Brown
Feedstuffs, Vol. 47, No. 24, p. 8, 44, June 16, 1975.

Descriptors: *Poultry, *Litter, *Fertilizers, Moisture, Nutrients, Georgia
Identifiers: Manure

Harry D. Muller, Georgia extension poultry specialist, told poultrymen and cattlemen that poultry litter may have excellent value as a fertilizer. He reported that for each ton of feed, 2,500 lb. of fresh manure is produced from a flock of birds. Muller found that fresh caged hen manure, with 37% moisture, can have a value of $25 a ton when the plant nutrient values are added up. Nitrogen losses can be reduced in ventilated, well-insulated houses and by using litter materials which can rapidly dry the manure. Muller recommends no more than two tons of dry or six tons of fresh manure per acre, on fields manured every year. (Cameron-East Central)

2354 - A8, D4 100

### HORN FLIES, STABLE FLIES, AND HOUSE FLIES: DEVELOPMENT IN FECES OF BOVINES TREATED ORALLY WITH JUVENILE HORMONE ANALOGUES

U. S. Livestock Insects Laboratory,
Agricultural Research Service, USDA,
Kerville, Texas
R. L. Harris, E. D. Frazer, and R. L. Younger
Journal of Economic Entomology, Vol. 66, No. 5, p. 1097-1098, October 15, 1973, 3 tab, 3 ref.

Descriptors: *Toxicity, *Additives, *Cattle
Identifiers: *Horn flies, *Stable flies, *House flies, *Juvenile hormone analogues

Seven tests were conducted at the U.S. Livestock Insects Lab in 1972-73 with 3 juvenile hormone analogues used as feed additives for control of the horn fly, the stable fly, and the house fly. Results indicate that Ro 7-9767 effectively inhibited development of horn flies and stable flies in the manure of the treated animal. When Ro 7-9767 was tested at the lower dosages, 1 g/day was the minimum dose that completely inhibited development of stable flies and horn flies. Development of stable and horn flies was inhibited in the manure of cattle treated with ZR-515. ZR-515 was the most active compound tested, since 0.7 mg/animal per day completely inhibited development of horn flies and 100 mg/animal per day completely inhibited development of stable flies. This compound did not completely inhibit development of house flies. When RO-20-3600 was mixed with the feed, 5 g/day inhibited development of horn flies and stable flies but not of house flies. No signs of clinical toxicity were observed in the cattle. (Cartmell-East Central)

## 2355 - A1, B2, E2 300

### SWINE WASTE MANAGEMENT

L. E. Hanson, J. MacGregor, H. Chiang, P. R. Goodrich and R. E. Larson
1973-1974 Minnesota Swine Research Reports, Preliminary Report H-240, Department of Animal Science in Cooperation with Agricultural Extension Service and Agricultural Experiment Station, University of Minnesota, 1973, p. 39-43. 2 tab.

Descriptors: *Crop response, *Corn, *Fertilizers, *Liquid wastes, *Pesticides
Identifiers: *Swine, *Waste management, *Land disposal, *Application rates, *Port Byron silt loam, *Waukegan silt loam

An extensive project on animal waste management was established in the Agricultural Experiment Station in 1970. Studies were then initiated at the Branch Stations in Crookston, Grand Rapids, Morris and Waseca. In 1972 a study of swine waste management was initiated at the Agricultural Experiment Station at Rosemount on two soil types. Liquid swine wastes from the anaerobic pits of growing-finishing buildings were applied at two rates in the fall of 1972. Corn was grown on these plots in 1973. The swine waste produced a remarkable increase in corn yields on one site (Port Byron silt loam) and had little effect on corn yields on one second site (Waukegan silt loam). The contrasting results are tentatively attributed to the previous cropping history of the sites. The study will be continued on 1974. (Hanson, et al.-Minnesota University)

## 2356 - A1, B2, E2 600

### SWINE WASTE MANAGEMENT

L. E. Hanson, J. MacGregor, H. Chiang, P. R. Goodrich, R. C. Munter, and R. E. Larson
Continuation Report of 1973-1974 Minnesota Swine Research Reports, Preliminary Report H-240, Department of Animal Science in Cooperation with Agricultural Extension Service and Agricultural Experiment Station, University of Minnesota, 1974, 2 p. 2 tab.

Descriptors: *Crop response, *Corn, *Fertilizers, *Liquid wastes, *Pesticides
Identifiers: *Swine, *Waste management, *Land disposal, *Application rates, *Port Byron silt loam, Waukegan silt loam

This is a continuation report of Preliminary Report H-240 of the "Minnesota Swine Research Reports, 1973-74." Following the 1973 corn harvest, the test plots were cleared and cored soil samples were taken. The plots were then treated with wastes from the anaerobic pits of growing-finishing buildings with application rates of none, 200 and 400 tons per acre. Corn was planted on May 17. Growth was terminated at the Waukegan site on September 3 and at the Port Byron site on September 21 by frost. The 1974 growing season had a wet spring followed by poorly distributed and inadequate rainfall. Consequently, total corn dry matter and grain yields were reduced. Total dry matter production varied from 93 to 97 percent of 1973 yields on the fertilized Port Byron plots and from 80 to 87 percent on the fertilized Waukegan plots. Corn yields varied from 70 to 80 percent of 1973 yields on the fertilized Port Byron plots and from 51 to 71 percent on the fertilized Waukegan plots. The pesticide (Furadan) applied at planting time apparently had little or no effect on corn yields of the Port Byron plots fertilized with swine waste. The pesticide had more effect in increasing corn yields on the Waukegan than on the Port Byron soils. (Merryman-East Central)

## 2357 - D4 100

### MICROBIAL NITRIFICATION AND DENITRIFICATION IN CONCENTRATED WASTES

Research Associate, Agricultural Waste Management Program, Cornell University, Ithaca, New York
T. B. S. Prakasam and R. C. Loehr
Water Research, Vol. 6, p. 859-869, 1972. 7 fig. 1 tab, 12 ref.

Descriptors: *Microbial degradation, *Waste water treatment, *Agricultural wastes, *Poultry, *Nitrification, *Denitrification, Municipal wastes

In view of the reported feasibility of microbial nitrification-denitrification methods for the removal of nitrogen from municipal waste, an experimental study was undertaken utilizing continuous flow and batch studies to obtain fundamental information on the applicability of such a method for the control of nitrogen from a concentrated agricultural waste. It was found that solids retention time values greater than 2 days sustained nitrification. Loading factors greater than 0.15#COD day -1#MLVSS-1 resulted predominantly in nitrite formation. Even at pH 5, nitrification was sustained. Free $NH_3$-N concentrations greater than 0.02 mgl-1 hindered nitrate formation resulting in nitrite predomination. $NO_2$-N had higher denitrification rates than $NO_3$-N. Denitrification of nitrified waste was accomplished without controlling pH. After the nitrified waste was denitrified, residual ammonia was left in the mixed liquor. A second nitrification of this denitrified mixed liquor resulted in complete oxidation of the residual ammonia. (Cartmell-East Central)

## 2358 - A1, B1, E2 100

### INDUSTRIAL WASTE AND AGRICULTURE IN GLAMORGAN

ADAS, Glamorgan
B. Rees
Agriculture (London), Vol. 78, p. 126-128, 135. 1971

Descriptors: *Industrial wastes, *Agriculture, *Reclamation, Sewage, Swine, Poultry
Identifiers: *Glamorgan

The restoration of former industrial land and the use of certain industrial by-products are helping agriculture in Glamorgan. 12,700 acres of opencast coal land has been restored for agricultural purposes and afforestation. Power station pulverised fuel ash is being used for motorways and as filler material for quarries, land depressions, and cut down woodland. Treated sewage water is being channeled to grasslands and solid sludge is a useful supplement to inorganic fertilizers on farms. Sawdust and wood shavings are being used as bedding in many agricultural areas. Disposal of lime-soda sludge on acid coal measure uplands is being considered for its ameliorative effect on grassland improvement. Swine and poultry manures are being used in the restoration of opencast coal land and derelict colliery tips. These are examples of ways that "wastes" can be put to use, particularly in the reclamation of derelict land. (Cartmell-East Central)

## 2359 - A1, B1, D4, E2, E3 100

### ANIMAL WASTE IN THE U. S. A.

Poultry Husbandry Adviser,
A.D.A.S., Worcester
B. Hodgetts
Agriculture, Vol. 79, p. 98-103, 1972. 3 fig.

Descriptors: *Animal wastes, *United States, Aerobic treatment, Poultry, Lagoons, Degradation
Identifiers: *Pollution, *Land spreading, Anaerobic treatment, Duck wastes, 'Bressler' system, Composting, Dehydrated poultry wastes, Fly larvae

This survey of American practice by an Englishman observes that "land spreading is still, of course, generally the cheapest, most efficient and most popular means of disposing of animal manures, but the economic cost of doing this may in some cases be so high as to make the system unattractive." Aerobic treatment of liquid wastes has advantages; its problems are foaming, sedimentation and high running costs. Aerobic treatment of solids by the "Bressler system (fan aeration in pits beneath cages) involves high capital costs. Composting is ineffective on poultry manure alone and, thus, involves blending with some other waste source. Anaerobic lagoons work admirably in the climate of Southern California with lagoon water being recirculated for flushing. Nutrient recycling and manure degrading with fly larvae are discussed. Fly larvae hold great promise in that "the activities of the young larvae aerate and successfully deodorize the manure in 2-3 days and remove 50 percent of its moisture. The larvae are allowed to pupate and when dried and ground the pupae may be used as a protein source for the growing chick. The remaining manure may be further dried or pelleted and can be used as a soil conditioner or fertilizer, or even as a feed for catfish. The manure from 100,000 hens is expected to produce between 500 and 1000 lb of pupae meal daily." (Whetstone, Parker, & Wells-Texas Tech University)

## 2360 - D4, E3 400

### MANURE SMELL FURNISHES FARMSTEAD'S POWER NEEDS

Eikenhof, Nr. Johannesburgh, South Africa
L. J. Frey
National Hog Farmer, Vol. 6, No. 3, p. 35-36, March 1961

Descriptors: *Gases, *Fertilizers, *Anaerobic digestion, *Recycling
Identifiers: *Manure, *South Africa

The use of dung to produce gas for furnishing a farm's power needs is discussed. A mixture of dung and water is placed in a digestor, where it is attacked by methane bacteria. The digestor is large so that the maintenance of the bacterial state is ensured — the contents being always alkaline. The process did not cause the decomposed dung to lose its fertilizing value: rather it was greatly improved. An analysis of the sludge showed that there was 10 percent dry matter, of which 5 percent was phosphates, 6.4 percent nitrogen, and 1 percent potash. There are some disadvantages to this system. Anaerobic decomposition generates no heat. Although heat must be applied, this can be done simply, without running cost. Alternatively, the gas can be used directly as it comes. Mr. Frey states that the gas is a very clean fuel. The wear is negligible and the sparking plug requires "tapping in" only once a month. Figures are given on the BTU obtained from the gas. The figures show the immense potential power available from dung, far greater than the heat available from burning dried droppings, and yet leaving the product as a fertilizer. (Kehl-East Central)

## 2361 - B2, C5 200

### THE FATE OF NITROGEN AND PHOSPHORUS IN AN OXIDATION DITCH TREATING SWINE WASTES

Professor of Civil Engineering,
Toronto University, Toronto 181, Canada
P. H. Jones and N. K. Patni

Presented at 45th Annual Conference, Water Pollution Control Federation, Atlanta, Georgia, October 12, 1972. 34 p. 16 fig. 4 tab, 20 ref.

Descriptors: *Nitrogen, *Phosphorus, Nitrification
Identifiers: *Swine, *Oxidation ditch, *Waste treatment, Wood shavings

Studies were made on the fate of nitrogen and phosphorus during a seven-month study of a full-scale oxidation ditch and a one-acre lagoon system that was used to treat the daily wastes from about 416 swine in the finishing barns of a hog breeding farm located 35 miles north of Toronto, Ontario. The cumulative total Kjeldahl nitrogen loading lost by the ditch mixed liquor (DML) was about 80 percent after 20 weeks and about 50 percent after 30 weeks of operation. Introduction of wood shavings in the DML appeared to inhibit nitrogen removal during the later stages. Conditions of pH, temperature, dissolved oxygen distribution of the DML and the daily load led to the conclusion that nitrogen removal was mainly by nitrification-denitrification sequence. About 15 percent of the phosphorus loading of the oxidation ditch was lost. It was presumed to have been absorbed on the loam soil beneath the unlined bottom of the ditch. (Cameron-East Central)

2362 - A5, E2 700

## NITRATE MOVEMENT IN SOIL UNDER EARLY SPRING CONDITIONS

M. F. Walter
Ph.D Thesis, University of Wisconsin, 1974, 147 p. 35 fig. 16 tab. 108 ref.

Descriptors: *Farm wastes, *Water pollution sources, *Frozen soils, *Fertilizers, *Leaching, *Path of pollutants, *Nitrates, *Soil water movement, Nitrogen, Soil profiles, Dispersion, Absorption, Computer models
Identifiers: Pasture management

Physical transport mechanisms and chemical transformations of nitrogen were investigated and a quantitative mathematical model was developed of manurial nitrogen movement through soil profiles under typical early spring conditions. Nitrogen transformation studies were conducted with batch systems of Plainfield sand and anaerobic dairy waste. Laboratory soil columns were used to investigate flow and transport processes. The specific conditions studied were temperatures from 0 to 20 degrees C, soil moisture from 5 to 20 percent by dry soil weight, soil pH from 6 to 8, and aerobic soil environment. The quantity of nitrate in an incremental volume of soil depended upon its movement in or out of the soil volume due to mass flow of water and to the net production of nitrate within the volume of soil due to mineralization of organic nitrogen and nitrification of ammonium. Nitrate accumulation as predicted by the computer model was based on nitrification of added manurial ammonium and soil nitrogen mineralization. Estimates of solute dispersion were made based on the movement of the soil water after infiltration. Laboratory soil columns incubated at different temperatures and with differing volumes of infiltration were used to simulate field soil conditions resulting after heavy land applications of anaerobic liquid dairy waste. Nitrogen measurements from these soil columns were compared with predictions from the computer model. (Selected Water Resources Abstracts)

2363 - A1, B1, C1, D4 700

## ACTIVATED-SLUDGE STABILIZATION OF SWINE WASTE

R. E. Hermanson
Unpublished Ph.D. Dissertation, Iowa State University, Ames, 1967, 102 p. 16 fig. 8 tab, 11 ref.

Descriptors: *Mathematical models, *Activated sludge, *Aeration, Waste treatment, Nitrification, Biochemical oxygen demand, Suspended solids
Identifiers: *Swine

This study is concerned with the stabilization of swine waste by the extended-aeration, activated-sludge process. The major objectives of the study were: (1) to develop a mathematical model for the BOD-reduction efficiency of the system, and (2) to verify the model and evaluate its coefficients by conducting experiments with a laboratory-scale system. The model's operation and performance were generally satisfactory. For most of the study, the mixed liquor pH remained in the optimum range for biological growth and the influent waste had adequate nitrogen and phosphorus for a proper nutritional balance. The activated sludge was odorless, flocculent, and settled well. Denitrification and foaming were not a problem. The reduction of BOD and suspended solids were satisfactory and there was a high degree of nitrification. An occasionally excessive discharge of suspended solids was caused by sludge bulking in the sedimentation. Provided the flow rate does not vary widely, excessive solids losses because of denitrification can be avoided by proper design of the sedimentation unit. The successful fitting of the mathematical model to the data was achieved by a non-linear, least-squares method that used a trial and error solution based on Hartley's modification of the Gauss-Newton method. Because extended-aeration, activated-sludge required less land than field spreading or lagooning, is essentially odor free, does not attract flies, and provides a high degree of BOD reduction, this system may be a desirable waste management alternative for the swine producer. (Kehl-East Central)

2364 - A1, B1, D4, E3 400

## BIO-GAS DISPOSAL SYSTEM NOT ON

Soil and Water, Vol. 19, No. 2, p. 47, December, 1973.

Descriptors: *Methane, *Costs, Anaerobic digestion, Effluent
Identifiers: *New Zealand, *Piggeries, *Bio-gas plant

A New Zealand study shows that the benefit from a bio-gas pig effluent disposal system would most probably not outweigh the costs of the system. Only industrialized countries with limited water supplies have high standards of industrial treatment. Heavy fines for failure to comply would therefore make a bio-gas treatment system economical. Since New Zealand generally has enough land and water for pig wastes to be discharged after 80-90 percent of the pollutant matter has been removed, it was advised that traditional treatment forms be maintained. (Kehl-East Central)

2365 - A9, B2, C4 100

## SURVIVAL OF CERTAIN PATHOGENIC ORGANISMS IN SWINE LAGOON EFFLUENT

Department of Veterinary Pathology,
Iowa State University, Ames
R. D. Glock, K. J. Vanderloo, and J. M. Kinyon
Journal of the American Veterinary Medical Association, Vol. 166, No. 3, p. 273-275, February 1, 1975. 1 fig, 2 tab, 12 ref.

Descriptors: *Lagoons, *Effluent, *Salmonella, *Anaerobic conditions, Sampling
Identifiers: *Pathogens, *Swine, *Survival, *Dysentery

This study involved 2 trials. In each trial, 3 pigs had access to plain water and 3 pigs were fed lagoon effluent. These pigs came from a closed herd with no evidence or history of salmonellosis or swine dysentery. Rectal swabs, necropsies, and samples of lagoon effluent were studied. Information obtained from these studies indicates that effluent from an anaerobic lagoon may be a source of infectious organisms. Salmonella spp were isolated from lagoon effluent as well as from the feces and tissues of pigs that drank the effluent as a sole source of water. All cultures submitted for typing were identified as S. saint-paul, of which the pathogenicity is unknown. Clinical signs typical of swine dysentery and enteric shedding of large numbers of spirochetes with the characteristics of Treponema hyodysenteriae were noted in 5 of the 6 pigs. Further study is needed to determine how long infectivity persists and whether there is growth of Salmonella spp, T hyodysenteriae, or other pathogens in the effluent. (Merryman-East Central)

2366 - A4, E2 400

## SWINE MANURE LAND APPLICATION RATES

Hog Farm Management, Vol. 9, p. 32-33, February 1972. 1 tab.

Descriptors: *Waste disposal, Nitrogen, Indiana, Water pollution
Identifiers: *Swine, *Land disposal, *Loading rates, Salt buildup

Land application of swine manure is recommended as a means of protecting surface and ground water from nitrogen and phosphorus excesses, of removing bacteria and pathogens through the "living filter" operation, of improving soil structure, and of least-cost disposal. Nitrogen should not be returned to the land in excess of crop use. The amount of manure per acre to contain this amount of nitrogen depends on the animal ration, the ammonia conversion and denitrification before application, the crop type, and the climate. Typical values for swine wastes on various crops in Indiana are tabulated. Salt buildup should also be considered. (Whetstone, Parker and Wells-Texas Tech University)

2367 - B1 300

## A COMPARISON OF FIVE HOUSING SYSTEMS FOR FEEDLOT CATTLE

West Central Experiment Station,
Morris, Minnesota
R. E. Smith, H. E. Hanke, L. K. Linder, R. D. Goodrich, J. C. Meiske, et. al.
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-170, p. 2-22. 15 tab.

Descriptors: *Feedlots, *Confinement pens, *Cattle, *Feeding, *Costs, *Performance, Density
Identifiers: *Housing systems, Efficiency, Gains

Because of the interest expressed by feedlot operators, a three year trial in Minnesota was conducted to study the influence of housing systems and the effect of animal density on feedlot performance. In the first year of study (1969-70), 324 Hereford steer calves (average initial weight of 435 lb) were allotted to five housing systems. In the second and third year, 340 calves (average weight of 431 lb. and 424.5 lb. respectively) were allotted to the five systems. The five housing systems were (1) conventional open shed with outside concrete lot, (2) manure pack confinement with manure scrape alley, (3) cold slat confinement, (4) warm slat confinement, and (5) open lot with dirt mound and windbreak fence. Except for the open lot, each facility was divided to provide two animal densities. All cattle were fed a ration composed of high moisture shelled corn, corn silage and supplement. Average daily gains for the 3 years were highest for cattle housed at 25 or 17 sq. ft./head in the warm slat unit (2.56 and 2.52 lb, respectively) followed closely by the cattle housed at 17 sq. ft. in the manure scrape unit (2.49 lb). Cattle in the open lot had the slowest average daily gains (2.21 lb). Feed cost/100 lb. gain for the 3-year summary were $12.88, $12.98, $13.45, $13.55, and $14.17 for cattle housed in the warm slat manure scrap, cold slat, conventional and open lot, respectively. (Cameron-East Central)

2368 - B2 300

### FINISHING YEARLINGS IN INSULATED HOUSING EQUIPPED WITH AN OXIDATION DITCH WASTE DISPOSAL SYSTEM: SUMMARY OF TEN TRIALS

J. C. Meiske, R. L. Larson, J. A. Moore, R. O. Hegg and R. D. Goodrich
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-171, p. 23-29.

Descriptors: *Feedlots, *Performance
Identifiers: *Oxidation ditch, *Housing, Floors, Carcass characteristics, Open shed, Insulated housing

The effects of four housing systems on feedlot performance and carcass characteristics of finishing yearling steers were summarized from 10 trials involving 527 cattle. The housing systems were: (1) conventional open shed, cattle self-fed outside, (2) insulated confinement with a slotted floor over an oxidation ditch, cattle self-fed, (3) insulated confinement with a slotted floor over an oxidation ditch, cattle fed twice daily, and (4) insulated confinement with a solid concrete unbedded floor, cattle self-fed. Cattle in confinement consumed less feed (P less than .01) and required less feed/100 lb gain (P less than .01) but gained at rates similar to cattle housed in the open shed. Carcasses of cattle fed in confinement have higher conformation scores and tended to have higher fat measures but graded similar to carcasses of cattle housed in the open shed. Economic calculations showed that lower returns per head resulted for all confinement fed cattle except those confined to an unbedded solid concrete floor in a year round feeding operation. (Meiske, et. al.-University of Minnesota)

2369 - B1 300

### COMPARISON OF HOUSING SYSTEMS FOR FEEDLOT CATTLE IN NORTHERN CLIMATES

Northwest Experiment Station,
Crookston, Minnesota
H. F. Windels, R. D. Goodrich, and J. C. Meiske
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-172, p. 30-38. 8 tab.

Descriptors: *Performance, *Confinement pens, *Minnesota
Identifiers: *Housing, *Cold confinement buildings, Carcass characteristics, Slatted floors

A trial involving 180 herd-mate steer and heifer calves was conducted to: (1) determine the winter practicality of a slatted floor, cold confinement building in northern Minnesota, (2) compare the performance and carcass characteristics of feedlot cattle housed in cold confinement buildings vs. a conventional pole barn, and (3) compare the performance of cattle housed in cold confinement buildings with either a gable or a shed roof. The cattle in the conventional barn gained significantly (P less than .01) faster (2.41 vs. 2.19, 2.14 lb) and required significantly (P less than .05) less feed/100 lb. gain (728 vs. 778, 781 lb) than cattle in the slatted floor cold confinement barns. Daily feed dry matter intakes were 17.5, 17.0, and 16.6 lb for cattle housed in a conventional barn, or confinement barns with either a gable roof or shed roof, respectively. These intake values were significantly (P less than .05) different from each other. Conventional housing and slatted floor cold confinement housing had similar effects on performance and carcass characteristics of steers and heifers. Performance data of cattle in confinement barns were not significantly influenced by the type of roof. Economic returns from cattle were significantly greater (P less than .01) for conventionally housed cattle than those housed in cold confinement slatted floor barns. (Windels, et. al.- University of Minnesota)

2370 - B1 300

### COMPARISON OF RATIONS WITH DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS FOR HOLSTEIN STEERS — A SUMMARY

Southern Experiment Station,
Waseca, Minnesota
K. P. Miller, J. C. Meiske, and R. D. Goodrich
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-173, p. 39-42, 5 tab.

Descriptors: *Diets, *Performance
Identifiers: *Rations, *Holstein steers, *Roughages, Corn silage, Hay

Trials which involved 260 head of Holstein steers fed rations with various concentrate to roughage ratios were summarized. Corn silage was used as a roughage source in all seven of the treatments which were compared. Steers fed rations which contained 28.7 or 55.4 percent corn silage dry matter (up to 750 lb) and 16.6 or 28.7 percent corn silage dry matter (from 750 lb to market) had faster rates of gain, were more efficient and produced higher grading carcasses than steers fed other rations containing corn silage. They also required fewer days of feeding and had higher returns. When hay was used as the roughage in the finishing rations in place of corn silage, the cattle consumed less feed, gained slower and required more feed dry matter per 100 lb gain. Steers fed rations with 86.2 percent corn silage dry matter had the slowest and least efficient gains, the lowest grades, the longest feeding period and the lowest returns. (Miller, et. al.-University of Minnesota)

2371 - B1 300

### MINERAL ANALYSES OF SOME COMMON MINNESOTA FEEDS

R. D. Goodrich, J. C. Meiske and A. El Fattah El Serafy
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-174, p. 44-46, 4 tab.

Descriptors: *Feeds, *Minnesota, *Analyses, Phosphorus, Potassium, Calcium, Magnesium, Iron, Zinc, Copper, Molybdenum, Manganese
Identifiers: *Minerals, Corn, Oats, Barley, Soybean meal, Linseed meal, Middlings

Samples of corn, oats, barley, soybean meal, linseed meal and middlings were analyzed for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), zinc (Zn), copper (Cu), molybdenum (Mo) and manganese (Mn) concentration in the dry matter. Average mineral contents and adjusted values, based on the variation among samples, were presented. When the adjusted values are used to estimate mineral contents of a feed, 84 percent of the time feed samples should contain at least that much of the mineral in question. If average values are used, half of the time the feed would contain less than that amount of the mineral in question. If several feeds are used to formulate a ration, the use of average analyses to predict mineral contents of the ration results in a more specific estimate of the average mixed content than if few feeds are used in the ration. However, both rations would contain less than the average amount of mineral half of the time. (Goodrich, et. al.-University of Minnesota)

2372 - B1 300

### INFLUENCE OF AN ANTIBIOTIC ON THE PERFORMANCE OF YEARLING HOLSTEIN STEERS

Department of Animal Science,
University of Minnesota
R. D. Goodrich, D. Crewford, and J. C. Meiske
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-177, p. 67-71. 5 tab.

Descriptors: *Antibiotics, *Performance
Identifiers: *Holstein yearlings, Chlortetracycline (Aureomycin), Liver abscesses

Thirty-two yearling Holstein steers were fed a ration without chlortetracycline (Aureomycin) and 31 were fed a daily ration that contained 70 mg of chlortetracycline. Cattle fed the antibiotic gained about 3 percent faster (3.13) vs. 3.04 lb/day), required about 5.5 percent less feed/100 lb gain (579 vs. 613 lb) and were more profitable than steers that did not receive antibiotic in their daily ration. Fifty-three percent (17 head) of the cattle that did not receive antibiotic had liver abscesses, while 29 percent (9 head) of those that received the antibiotic had liver abscesses. (Goodrich, et. al.-University of Minnesota)

2373 - B1, E3 300

### FEEDING VALUE OF CORN RECLAIMED FROM AN OXIDATION DITCH AND THE INFLUENCE OF ADDING WATER TO RATIONS FOR FINISHING STEERS

Department of Animal Science,
Minnesota University
J. C. Meiske, R. D. Goodrich, R. L. Larson, J. A. Moore, and R. O. Hegg
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-180, p. 84-88. 3 tab.

Descriptors: *Corn, *Recycling, *Water
Identifiers: *Rations, *Oxidation ditch, *Finishing steers, Feed value

Holstein steers were used to estimate the feeding value of corn that had passed through the digestive tract of finishing steers and which was reclaimed from an oxidation ditch and ensiled. The influence of adding water to an all-corn ration was also investigated. Cattle fed rations that contained 21 percent reclaimed corn dry matter performed satisfactorily, but those fed rations containing 44 percent reclaimed corn dry matter gained less rapidly. Although both groups consumed more feed per head daily than cattle fed an all-corn diet containing dry corn, both were less efficient. It was calculated that the dry matter of the ensiled, reclaimed corn had feeding values about 40 percent of that of regular corn dry matter. When water was added to regular corn to make a corn mixture of 71 percent dry matter, the cattle consumed about 3.5 percent more feed dry matter daily; when sufficient water was added to regular corn to make a corn mixture of 59.9 percent dry matter, the cattle consumed approximately 3 percent less feed dry matter daily. However, cattle in the treatment groups which had water added to regular dry corn at feeding time required 11.2 to 15.9 percent less dry matter per 100 lb gain than steers fed only dry corn. (Meiske, et. al.-Minnesota University)

2374 - B1 300

### INFLUENCE OF SALT LEVELS WITH AND WITHOUT SUPPLEMENTAL POTASSIUM ON THE PERFORMANCE OF STEER CALVES

Department of Animal Science,
Minnesota University
D. W. Crawford, J. C. Meiske, and R. D. Goodrich
1972 Minnesota Cattle Feeders' Report, University of Minnesota, Research Report B-181, p. 89-98. 7 tab.

Descriptors: *Salts, *Potassium, *Performance, *Cattle, *Feeds, Weights, Feedlots
Identifiers: Gains, Carcass characteristics

A trial was conducted to determine the influence of various levels of supplemental salt on steer calves fed a corn silage-corn grain ration and to investigate the influence of supplemental potassium on salt requirements. Fifty-five Hereford steer calves (average initial weight of 446 lb) were randomly assigned to eight pens. Each pen of cattle was then randomly assigned to each of eight treatments ranging from 0.0 g salt plus 0.0 g potassium per head daily to 37.5 g salt plus 10.0 g potassium per head daily. All calves were fed 10 lb of corn silage and 1 lb/head daily of the respective supplement that supplied the appropriate levels of salt and potassium. Average daily gains were 2.34 lb/head for steers fed no supplemental salt and 2.81, 2.73, and 2.88 for steers fed 12.5, 25.0, and 37.5 g of salt per head daily. Steers fed the lowest level of supplemental salt (12.5 g) had adequate rates of gain, feed intakes, feed efficiencies and carcass characteristics. Steers fed supplemental potassium gained faster than steers receiving no supplemental potassium (2.76 vs. 2.62 lb/head daily). The feeding of potassium also increased feed intake, improved feed efficiency, and lowered feed cost per 100 lb of gain. Carcass characteristics were not significantly influenced by the feeding of supplemental potassium. Results suggest the level of salt may be reduced below present recommended level of 36 to 45 g per head daily (0.08 lb to 0.1 lb/head daily). The feeding of potassium carbonate may result in a slight increase in returns to labor and management when cattle are fed high rations. (Cameron-East Central)

2375 - B2, E2 400

### MANAGING ANIMAL WASTE DISPOSAL SYSTEMS

E. D. Anderson
Farm Quarterly, Vol. 27, No. 2, p. 56-58, 1972.

Descriptors: *Lagoons, Design, Sprinkler irrigation, Costs
Identifiers: Land disposal

The poor reputation that lagoons have acquired in some areas is often the result of inadequate design, poor location, and/or improper management. They can be effective in Missouri, less so to the north, and more so to the south. Management suggestions include keeping the water level nearly constant, starting the lagoon at the beginning of warm weather, keeping the pH above 6.7 by adding lime or lye, loading continuously or at least daily, allowing two years for the lagoon to stabilize, and pumping out annually. (Whetstone, Parker, and Wells-Texas Tech University)

2376 - B1, E2 400

### HOW TO DISPOSE OF MANURE AND STAY OUT OF COURT

E. D. Anderson
Farm Quarterly, Vol. 27, No. 4, p. 52-56, 1972.

Descriptors: *Waste management, *Legal aspects, *Feedlots, *Cattle, *Dairy industry, Costs, Irrigation, United States
Identifiers: *Canada, Swine, Land disposal

All states and Canadian provinces now prohibit discharge to surface or underground waters. Consult the applicable law before starting or enlarging an operation. Note the distances to downwind neighbors. Adequate spreading areas should be owned or held under long-term lease. Suggestions and cost estimates are given for beef, dairy, and swine operations. (Whetstone, Parker, and Wells-Texas Tech University)

2377 - A1, E2 300

### BROILER AS A FERTILIZER

L. H. Hileman
Arkansas Farm Research, January-February, 1965, p. 6. 3 fig.

Descriptors: *Fertilizers, Nutrients
Identifiers: *Broiler litter, *Land disposal, Yields, Application rates, Forage response

In 1964 an experiment was established to evaluate the response of fescue to rates of litter application. Broiler litter was broadcast by hand at rates of 0 to 20 tons per acre, in 2-ton increments plus two very high treatments of 25 and 30 tons per acre. The litter contained 23% moisture, 4.4% nitrogen, 2.60% phosphorus, and 1.95% potassium. The 2-, 4-, and 8-ton rates yielded more forage than no treatment. However, the 4-ton per acre rate significantly increased yields. Yields from the 10- and 12-ton rates were similar to the no treatment. The 25- and 30-ton rates eliminated almost all plant growth. Observations indicated that continued applications of rates exceeding 4 tons per acre may tend to increase the intensity of the yield-depressing effect of high rates of broiler litter. (Cameron-East Central)

2378 - A1, B1, D1, E2, E3 400

### MANAGEMENT AND UTILIZATION OF POULTRY WASTES

J. R. Howes
Feedstuffs, Vol. 40, No. 50, p. 22-23, December 14, 1968. 3 fig.

Descriptors: *Litter, *Waste treatment, *Waste disposal, *Chemical properties
Identifiers: *Poultry wastes, *Cage manure

This discussion deals with the disposal or reuse of poultry litter and cage manure. Content of poultry litter and of cage manure is variable. Poultry litter usually contains about 20-25 percent moisture and 2 percent each of nitrogen $P_2O_3$ and $K_2O$. Cage manure contains approximately 75 percent moisture and much less nitrogen, $P_2O_3$ and $K_2O$ because of the dilution. Present day methods of efficiently disposing of poultry wastes include landfill, spreading it as fertilizer, composting, drying, or feeding to poultry and livestock. The advantages of each of these methods are discussed. It is pointed out that recent studies indicate that organic fertilizers are capable of controlling soil nematodes which have not been economically controlled to date in citrus, peach, grass and many other crops. Also, organic manures contain stabilized nitrogen and phosphorus, which, if these products are not over-applied to the land, will not leach out polluting soil water, giving rise to nitrate poisoning, stream and lake eutrophication. (Merryman-East Central)

2379 - A5, B2, D4 700

### OXYGEN TRANSFER RELATIONSHIPS IN A POULTRY WASTE MIXED LIQUOR

D. R. Baker
MS Thesis, Cornell University, Ithaca, New York, August, 1973, 132 p. 27 fig, 5 tab, 55 ref.

Descriptors: *Waste treatment, *Poultry, *Aeration, Temperature, Viscosity
Identifiers: *Oxidation ditch, *Oxygen transfer, Solids

Liquid aerobic treatment systems have been found to be effective devices for handling and controlling odors in animal wastes. The purpose of this study was to examine oxygen transfer and uptake relationships of wastewaters at solids concentrations similar to those found in actual waste treatment systems. All of the results and conclusions apply to an aerated mixed liquor in an oxidation ditch which has reached a steady state equilibrium condition. The study showed that oxygen uptake rates were not affected either by temperatures or solid concentrations normally encountered in an in-house oxidation ditch. The results indicated that viscosity measurements can be related to oxygen transfer values. Although the rotor's oxygen transfer rates were not affected by the range of temperatures encountered, increases in solids concentrations did decrease the capability of the rotor to transfer oxygen. (Kehl-East Central)

2380 - A1, A5, B1, D4, E2 100

### BIOLOGICAL TREATMENT OF POULTRY MANURE COLLECTED FROM CAGED LAYING HENS

Department of Microbiology,
Guelph University, Guelph, Ontario, Canada
R. G. Bell
Compost Science, Vol. 10, No. 3, p. 18-21, Autumn, 1969, 4 fig, 4 tab, 7 ref.

Descriptors: *Waste treatment, *Biological treatment, *Poultry, Odor, Water pollution, Anaerobic digestion, Flocculation
Identifiers: *Caged laying hens, *Composting, Settling, Extended aeration, Settled solids

As a consequence of the increasing urbanization of agricultural areas, animal production units are becoming surrounded by residential property. Because of the intolerance of the new neighbors and the pollution authorities for obnoxious odors or the pollution of surface waters, better farm management is essential. This is the major reason for the great need for the development of treatment processes by which animal wastes can be converted into valuable soil amendments which lack such objectionable properties. The objective of this study was to attempt to produce a soil amendment which could be applied without creating an odor nuisance or a surface water pollution hazard, from poultry manure collected from both liquid and solid manure management systems. This study was limited to the treatment of the wastes produced by caged laying hens. Several methods were used to attempt to produce stable nonodorous products from poultry manure collected from a liquid manure handling systems. They were: flocculation, anaerobic digestion, settling, extended aeration and composting. All the treatments proved unsatisfactory except composting, which was restricted to the coarsest fraction of the settled solids. The success of composting fresh poultry manure in association with ground corn cob, another agricultural waste, has led to the construction of a pilot scale composting plant. The effects of aeration and the addition of old compost on composting are given. (Kehl-East Central)

2381 - A1, E2 100

### COMPARISON OF INORGANIC NITROGEN CONTENTS OF UNDISTURBED, CULTIVATED, AND BARNYARD SOIL PROFILES IN WISCONSIN

Department of Soils and Agricultural Engineering
Wisconsin University, Madison
R. J. Olsen, R. F. Hensler, O. J. Attoe, and S. A. Witzel
Soil Science Society of America Proceedings, Vol. 34, No. 4, p. 699-700, July-August, 1970. 1 tab, 9 ref.

Descriptors: *Nitrates, *Nitrites, *Soil profiles, *Wisconsin, *Water pollution, *Soils
Identifiers: Exchangeable ammonium

The need for adequate disposal of increasing amounts of livestock wastes suggests that pollution of subsurface and surface waters from this source is likely to become of greater importance. The purpose of this study was to obtain information on the contents of nitrate and other forms of inorganic nitrogen in soil profiles under various conditions in Wisconsin, particularly from cultivated fields, undisturbed or virgin locations, and from barnyards. The average total content of $NO_3$-N in the profile was lowest for the undisturbed soils and highest for the cultivated soils. The values for $NO_2$-N were much lower. They were lowest in the well-drained barnyard profiles and highest in the poorly-drained ones. The values for exchangeable $NH_4$-N varied more widely between profiles, were lowest for the cultivated soils and highest for the poorly-drained barnyard soils. The concentration of $NO_3$-N tended to decrease with soil depth, apparently because of denitrification, microbial immobilization processes and plant uptake. The total content to the 240-cm depth of $NO_2$-N ranged from 6 to 25 kg/ha. The results suggest that contamination of the groundwater with $NO_3$-N from animal wastes would mainly concern farm families that consume water from wells located too close to barnyards and feedlots. Excessive rates of applying fertilizer N should be avoided. (Kehl-East Central)

2382 - A1, B1, D1, E2 300

### ANIMAL WASTE MANAGEMENT WITH POLLUTION CONTROL

J. R. Miner and W. E. Verley
Oregon State University, NC-93 Annual Report, October 1974 27 p. 9 fig, 12 tab, 6 ref.

Descriptors· *Lagoons, *Economics, *Odor, *Ohio, Soils, Agricultural runoff
Identifiers: *Pollution control, *Animal waste management, *Swine, *Composting, *Land disposal, Application rates, Groundwater quality

The Agricultural Engineering Department continued to evaluate handling swine waste with flushing and a two stage lagoon system. Experimental objectives were: to determine the treatment efficiency of the system, measure the nitrogen losses in each unit, determine whether ground water pollution occurs from the lagoons, and to evaluate the system with respect to equipment system effectiveness, and economics. In another experiment, a built-up bed, aerobic composter was designed to provide both treatment and storage capability. Evaluations of rate of application, type and condition of manure, temperatures achieved within the composting mass and resultant compost quality and condition are in progress. Other projects underway include modeling livestock waste systems and studies of malodorous substances and their abatement. The Agronomy Department has installed field lysimeters to determine the maximum rate of cattle manure that can be applied to various Ohio soil types without adversely affecting groundwater quality. Cooperative research has been initiated through a Memorandum of Understanding between the Ohio Agricultural Research and Development Center and the USDA-ARS-North Appalachian Experiment Watershed, Coshocton, Ohio. Numerous watersheds are available to study runoff from pastures and feedlots. Cow herds will be managed under 3 systems: (1) limited stocking rate and fertilizer application with grazing during the growing season only; (2) high stocking rate and fertilizer application with year-long grazing and; (3) moderate fertility and stocking rate with hay fed on pasture during winter. Cattle will be fed in drylot with varying proportions of concentrates and roughages. Runoff, ground water and soil sediments will be analyzed for N, P, K, BOD, etc. where applicable. (Ohio Agricultural Research and Development Center; abstract edited by L. Merryman)

2383 - A1, B1, D1, E1, F1, F2, F3 200

### ECONOMIC ASPECTS OF FEEDLOT WASTE POLLUTION

Department of Agricultural Economics
M. Baker
Proceedings, Pollution Research Symposium, Lincoln, Nebraska, May 23, 1969, p. 46-49. 4 ref.

Descriptors: *Economics, *Feedlots, *Farm wastes, *Standards, Odor, Fish kills, Agricultural runoff, Aesthetics, Water pollution
Identifiers: *Pollution control

Feedlot waste pollution control is looked at from an economist's point of view. It is recognized that feedlots may ultimately pollute water with bacteria and high nitrate levels, that they may be the source of unpleasant odors, that they may be the cause of fish kills, and that they may be aesthetically offensive. It is also recognized that pollution control standards must be met. But how and to what extent? The cost of this pollution control will probably be borne by the cattle industry. Most of the cost will probably be borne by the producer of feeder cattle. This could cause shift of production area, elimination of smaller feedlots, and added competition from animal substitute products such as synthetic meats. The impact of meeting pollution control standards is a matter of speculation. Continued research is needed in order to determine what pollution control standards should be met and how they should be met. (Battles-East Central)

2384 - A9, B2, D4 300

### SURVIVAL OF PATHOGENS IN ANIMAL MANURE DISPOSAL

Minnesota University, St. Paul
S. L. Diesch, B. S. Pomeroy, and E. R. Allred
Environmental Protection Agency Report No. EPA 670 2 73 051, Minnesota University, St. Paul, August 1973. 135 p.

Descriptors: *Pathogenic bacteria, *Waste disposal, *Model studies, Slurries, Sludge, Temperature, Cattle, Minnesota
Identifiers: *Oxidation ditch, *Survival, *Leptospira pomona, *Salmonella typhimurium, pH

A laboratory model (1:10 scale) of an operational field oxidation ditch used in beef cattle production was utilized in survival and detection studies of Leptospira pomona and Salmonella typhimurium. Minnesota summer (20C) and winter (2C) temperatures, pH, and dissolved oxygen of field ditch manure slurry were simulated in laboratory model studies of manure slurry, effluent, and sludge. Maximum leptospiral survival times of 138 days (summer) and 18 days (winter) in the slurry were measured. Salmonella survival of 47 days in slurry and 87 days in sludge (winter), and 17 days in slurry (summer) were measured. Adequate laboratory cultural detection and isolation techniques were developed to measure survival. Findings from simulated studies in a second laboratory model were used to separate materials for recycling. (Diesch et. al.-Minnesota University)

2385 - A1, B2, E2 700

### PHYSICAL PROPERTIES OF A COLO SILTY CLAY LOAM SOIL DURING TWO YEARS' IRRIGATION WITH EFFLUENT FROM BEEF FEEDLOTS AND WATER FROM A CREEK

D. H. Hinrichs
Unpublished M. S. Thesis, University of Nebraska, Lincoln, 1973, 74 p. 10 tab, 18 append., 51 ref.

Descriptors: *Physical properties, *Irrigation, *Effluent, *Feedlots, *Nebraska, *Water, Cattle, Rainfall, Agricultural runoff, Management, Waste disposal, Moisture
Identifiers: *Colo silty clay loam

A study was done to obtain information on the influence of effluent applications on soil physical properties and to recommend management practices. The field site was located on the flat area between the footslopes and a nearby creek. There were 15 plots consisting of five treatments replicated three times. The following tests for physical properties of soil were conducted on the soil samples: particle size analysis, bulk density, moisture release, water stability of aggregates, hydraulic conductivity, and rainfall splash. Results showed the soil for the plot area to be a Colo silty clay loam with 2.1% sand, 68.1% silt, and 28.6% clay. There were significant differences in bulk density for treatments and dates of sampling. No obvious differences in moisture release curves were noted from the application of effluent. Geometric mean diameters of water stable aggregates were not influenced by the irrigation. Leaching occurred during the 1971-72 season of irrigation when 54 cm of rainfall was recorded for the period of October through May. (Cameron-East Central)

2386 - A1, B1, D1, E2, E3 300

### ANIMAL WASTE MANAGEMENT IN TEXAS: TESTIMONY PRESENTED TO THE SOLID WASTE STUDY COMMITTEE OF THE TEXAS HOUSE OF REPRESENTATIVES

Texas Agricultural Extension Service,
Texas A&M University, College Station
J. M. Sweeten
Memo AENG 6, Texas Agricultural Extension Service, Texas A&M University, College Station, Texas, 1972, 10 p.

Descriptors: *Animal wastes, *Texas, *Feedlots, *Cattle, Proteins, Recycling, Poultry, Water pollution, Dehydration, Fertilizers, Odor
Identifiers: *Waste, Land disposal, Application rates, Building materials, Refeeding, Pyrolysis, Turkeys

Beef feedlots account for 65 percent of the animal manure (dry weight basis) in Texas. Of the total tonnage, 70 percent is from lots which do not contribute to surface runoff under storms of less than once-in-25-years frequency. Other lots are being upgraded toward this goal. Land disposal provides fertilizer and soil conditioning benefits. No salt build-up occurs with application rates below 300-900 tons/acre. "To summarize, land disposal of solid beef feedlot wastes at rates consistent with sound agronomic practice gives benefit-cost ratios of about 2:1 or 3:1." Other methods cited are conversion to a protein source by thermophilic bacteria (GE-Casa Grande, Arizona), conversion to building materials by mixing with glass and heating at atmospheric pressure to 300-400 degrees C and 3000-4000 psi, refeeding as a fermented mixture of manure and hay, and pyrolysis with ammonia recovery. Turkey feedlots contribute to water pollution. It is usual in Texas to move the pens rather than the manure, utilizing the fertilizer value of the manure where it falls. Caged layers produce a high-nitrogen waste. Dehydration and refeeding appear promising. Sweeten urges a cautious approach to this solution. Broiler manure has value as a fertilizer and in cattle feed rations. For dairy cattle and swine, liquid manure handling is usual. Odor problems arise. Lagooning provides little economic return. Slurry irrigation by pipeline and spray nozzle or by storage pit and honey wagon is recommended. (Whetstone, Parker, & Wells-Texas Tech University)

2387 - D4, E2 300

### BIOLOGICAL TREATMENT OF BEEF ANIMAL WASTES

Water Resources Research Institute,
Kansas State University, Manhattan
L. A. Schmid and R. I. Lipper
Completion Report No. 77, Water Resources Research Institute, Kansas State University, Manhattan, June 1971, 59 p. 17 fig, 12 tab.

Descriptors: *Anaerobic digestion, *Waste treatment, Irrigation
Identifiers: *Oxidation ditch, *Land disposal, *Loading rates, Liquification

An anaerobic digestion system and an oxidation ditch system were employed in this study to investigate the treatment, handling, and disposal of the confined beef animal wastes. Considering only acid fermentation, the process permits the use of the anaerobic digester under little skilled supervision for manure liquification. Uncontrolled field environmental factors, such as low temperatures, low pH, and intermittent and shock loading do not inhibit the acid forming bacterial activities which are responsible for liquifying the organic solids. The liquified manure is more readily degradable for further treatment. can be returned to the soil for agricultural irrigation, and has less pollutional strength for disposal on land. The anaerobic digestion system for solids liquification can be one answer to handling, holding, and disposing of the confined beef animal wastes. The oxidation ditch system, with a loading of one animal per 60 cu. ft. of liquid volume, provides a potential treatment of beef animal wastes. The two rotors in this system, with a speed of 200 r.p.m. and an immersion depth of 3 inches, are capable of maintaining adequate waste velocity and oxygenation. (McKenna-Kansas Water Resources Research Institute)

2388 - A1, D1 300

### SOIL MODIFICATION FOR DENITRIFICATION AND PHOSPHATE REDUCTION OF FEEDLOT WASTE

Department of Crop and Soil Sciences,
Michigan State University, East Lansing
A. E. Erickson, B. G. Ellis, J. M. Tiedje, C. M. Hansen, and F. R. Peabody

Environmental Protection Agency, Technology Series Report EPA-660/2-74-057, June 1974, 118 p. 9 fig. 24 tab. 10 ref.

Descriptors: *Denitrification, *Aerobic treatment, *Soil treatment, *Farm wastes, *Phosphates, *Waste water treatment, Hogs, Dairy industry, Anaerobic conditions, Waste treatment, Feedlots, Biodegradation, Pilot plants
Identifiers: Barriered landscape water renovation systems, Organic matter decomposition, Phosphate fixation

The efficiency of pilot-size Barriered Landscape Water Renovation Systems (BLWRS) to renovate flushed livestock waste was studied. The BLWRS is a modified permeable soil that has an aerobic zone for the filtering and oxidation of the waste and an anaerobic zone to which an energy source is added to create an environment for denitrification. Two pairs of BLWRS 0.008 ha. in size were constructed using a polyvinyl barrier to create the anaerobic zone and contain the effluent. Flush wastes from swine or dairy cattle were applied on each pair of BLWRS. The waste effluents and BLWRS soil were periodically analyzed for nutrients, oxygen demand and pathogens. At manure loading rates of up to 122 t/ha. swine waste and 93 t/ha. of dairy waste, the BLWRS had an efficiency of 80 percent and 97 percent for nitrogen renovation, greater than 99 percent for phosphate and 93 percent for carbon. The oxygen demand dropped 50- to 100-fold. Under normal operating conditions, the pathogenic indicator organisms did not appear in the effluent. The BLWRS has been shown to be an efficient system for renovating large quantities of livestock waste and should be tested on a commercial scale with continuous monitoring. (EPA) (Selected Water Resources Abstracts)

## 2389 - B1, D1, E1· E2 100

### INDUSTRIAL AND AGRICULTURAL SOLID WASTE AND PROBLEMS INVOLVED IN THEIR DISPOSAL

Chief, Basic Data Branch, Division of Technical Operations, Bureau of Solid Waste Management, Environmental Control Administration, Consumer Protection and Environmental Health Service, Cincinnati, Ohio
T. J. Sorg
Public Health News, Vol. 51, No. 3, p. 67-69, March 1970. 2 ref.

Descriptors: *Industrial wastes, *Solid wastes, *Agricultural wastes, *Waste treatment, Waste disposal, Recycling

The solid waste generated from an industrial plant may be classified into five categories based on source: 1. cafeteria waste; 2. packaging and shipping waste; 3. office waste; 4. general plant operation waste; 5. processing waste specific to the industrial plant. To determine the state of the art of industrial waste management practices, the Bureau of Solid Waste Management is conducting a number of studies and surveys on various industries on a national basis. An area being explored that will play a significant role in waste management is the utilization or reprocessing of industrial solid waste. Agricultural solid waste problems differ from industrial solid waste problems. The physical and chemical composition of the agricultural solid waste is not as varied as industrial solid waste. Agricultural wastes are primarily animal manure and bedding; dead animals; and the leaves, stalks, stubble, and culls from agricultural crops. The amount of agricultural waste produced annually exceeds the solid waste production from any other segment of the economy. The traditional disposal method for manures has been to spread them on land, but this method is often impractical. Further research must be done. Two waste management alternatives being demonstrated by the Bureau of Solid Waste Management are utilization of lagoon treatment processes for dairy manure and long-distance pipeline transport of sludge for disposal on land. (Cartmell-East Central)

## 2390 - A2, C3, C5 700

### CATTLE FEEDLOT WASTEWATER SALINITY

Tsao, Ter-Fung
MS Thesis, Department of Civil Engineering, Colorado State University, March 1972, 80 p. 15 fig. 19 tab. 44 ref.

Descriptors: *Feedlots, *Cattle, *Waste water (pollution), *Salinity, *Agricultural runoff, *Feeds, Nutrients, Sampling, Chemical analyses

In this study, cattle manure samples from different feedlots with different salt concentrations in the feed were analyzed to determine how the salt concentration in the feed affects the salinity of the manure solution. Fresh manure samples from different pens of both university feedlots and commercial feedlots were collected for laboratory analysis. It was found that the more salt cattle feed contains, the higher is the specific conductance of the manure solution and the greater is the dissolved volatile and non-volatile solids content in the fresh manure. The logarithm of the sodium absorption-ratio of the one percent manure solution is proportional to the specific conductance of the solution. These facts demonstrate that the salt in cattle feed increases the water salinity problem of cattle feedlot runoff. (Cartmell-East Central)

## 2391 - A1, B1, D1, E2, E3 200

### A REPORT FROM PENNSYLVANIA STATE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

Department of Animal Science,
Pennsylvania University
L. L. Wilson, T. A. Long, H. D. Bartlett, G. O. Bressler
Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 35-43. 14 ref.

Descriptors: *Recycling, Livestock, Insecticides, Fertilizers, Feeds, Sawdust
Identifiers: *Refeeding, Horticultural wastes, Dried poultry wastes, Waste paper, Garbage

The projected increase in the world's population within the next few decades emphasizes the need for conserving existing resources and for utilizing them efficiently. This means that wastes resulting from agricultural production and processing need to be recycled. Among options for the agricultural producer are the following. Horticultural wastes could be fed to ruminants. However the feeding of apple wastes in the early 1960's resulted in approximately 76 p.p.m. of DDT being deposited in fat tissues of the waste-fed cattle; consequently, use of pesticides must be taken into consideration. Treated poultry waste rations may be used as a feed for ruminants. Liquid manure may be disposed of on grasslands. Sawdust may be used as a substitute roughage for cattle. Waste paper may be used in the ruminant diet. Paper manufacturing wastes may be fed to ruminants. Dried poultry manures may be used as fertilizers, mulches and animal feeds. Milk-house liquid wastes may be distributed to the land through a sprinkler irrigation system. Dried cottage cheese whey is a potential powdered milk substitute. The suitability of digested soft urban garbage is under study for its suitability as a fertilizer or as a feed source for ruminant animals. These are all recycling possibilities that have been the subject of past or present study. (Merryman-East Central)

## 2392 - A2, A5, B1 200

### A PERSPECTIVE FOR CONNECTICUT

Connecticut University
J. J. Kolega
Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 44-48.

Descriptors: *Connecticut, *Poultry, *Dairy industry, Agricultural runoff, Odor, Water pollution, Septic tanks, Research and development
Identifiers: *Waste management, Horses

Agricultural waste problems in Connecticut are primarily those associated with the poultry and dairy industry. Prime problems for the dairy industry are surface runoff from paved areas; surface discharges into streams or into a drinking water supply watershed, and milking center discharges. The poultry producer's problems are even more serious due to the small amount of land accomodating his operations and due to the corresponding population growth around these operations. The major complaints against the poultry producer have been directed toward the odors emanating from his facilities. Another problem requiring attention in Connecticut is the handling of septic tank pumpings. About two-thirds of Connecticut's geographic area is estimated to be using septic-tank disposal systems or their equivalent. University of Connecticut studies related to these three problem areas are listed with corresponding addresses. A relatively new problem area developing in Connecticut is related to the influx of pleasure horses. A general recommendation for the handling of the wastes from these animals has not yet been developed. (Merryman-East Central)

## 2393 - A1, E2 200

### PLANT NUTRIENT BUDGETS AND WASTE DISPOSAL

Connecticut Agricultural Experiment Station
C. R. Frink
Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 49-52. 1 tab. 5 ref.

Descriptors: *Nutrients, *Waste disposal, *Nitrogen, *Phosphorus, *Connecticut, *Eutrophication, Fertilizers, Dairy industry
Identifiers: *Land disposal

One of the most pressing environmental concerns in Connecticut is the enrichment of lakes and streams with plant nutrients that encourage the growth of weeds and algae. The nutrients responsible for these problems may come from fertilizers, animal and human waste disposal, or erosion from a new housing development. The largest single source of plant nutrients in Connecticut, excluding human waste, is dairy farming. Efficiency of nutrient conversion by land used in waste disposal decreases as farm size decreases. Every effort should be made in the Northeast to keep land available so that crops may utilize the applied nutrients more efficiently. Agronomic approaches reducing nitrogen losses include application of fertilizer and manure to growing crops rather than to bare or frozen soil, selection of crops with both high yield and high protein content, increased plant populations, and more extensive use of cover crops. (Merryman-East Central)

## 2394 - A1, B1, E2, F1 200

### ANIMAL WASTE MANAGEMENT IN MODERN PRODUCTION SYSTEMS

Department of Poultry Science,
Cornell University, Ithaca, New York
R. J. Young
Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 53-60. 6 ref.

Descriptors: *Waste disposal, *Research and development, *Waste treatment, Odor, Water pollution, Nutrients, Fertilizers, Dehydration, Incineration
Identifiers: *Waste management, *Land disposal, Oxidation ditch

The design of animal production units of the future must take into consideration the conditions necessary for optimum production with a management system that will minimize environmental pollution. The encroachment of resort and residential developments into rural areas increases this necessity. It is essential that the cost of livestock operation include waste handling and disposal costs. In the College of Agriculture at Cornell University, an Interdepartmental Task Force has been developed with representatives from the Departments of Agricultural Economics, Agricultural Engineering, Agronomy, Animal Science, Food Science, and Poultry Science to investigate such management problems as waste disposal systems, odor identification and control, water pollution prevention, nutrient removal, reutilization of animal wastes as fertilizers or foodstuffs, and new methods of waste management which can economically become part of the total production system. Studies discussed include: (1) use of an oxidation ditch in a poultry house, (2) incineration of poultry manure, (3) dehydration of poultry manure with heated air, and (4) water pollution from land disposal of manure. (Merryman-East Central)

2395 - A1, A4, B1, D1, E2 200

## TREATMENT AND DISPOSAL OF ANIMAL WASTES IN MASSACHUSETTS

**Massachusetts University**
**J. T. Clayton**
**Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 61-67.**

**Descriptors: *Massachusetts, *Waste treatment, *Waste disposal, *Research and development, *Animal wastes, Aeration, Effluents, Nitrogen, Groundwater pollution, Lagoons, Ponds**
**Identifiers: Land disposal**

In an attempt to provide usable engineering design information, studies of several components of treatment systems are being conducted. Under study are the following (1) An extended aeration system of manure mixed with water to form a slurry. (2) The effects of disposal of effluent from the above mentioned system at a subsurface level in terms of chemical, microbiological, and physical properties of constructed profiles, as well as the degree of tertiary treatment in the soil. (3) Distribution of animal waste effluents within the soil with an orifice or nozzle that can reliably effect uniform discharge. (4) Flow of nitrogen through the soil with the purpose of establishing what effect adsorption of nitrogen by soil particles would have on nitrogen contamination of groundwater in the vicinity of waste stabilization ponds. (5) The effects of groundwater on the movement of nitrogen in soils adjacent to lagoons or ponds. (Merryman-East Central)

2396 - A1, B1, F2 200

## AN ASSESSMENT OF THE AGRICULTURAL AND PROCESSING WASTE PROBLEMS AND CONTROL IN WEST VIRGINIA

**West Virginia Agricultural Experiment Station**
**A. D. Longhouse**
**Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 68-73. 1 tab.**

**Descriptors: *Regulation, *West Virginia, *Agriculture, *Water pollution, *Air pollution, Soil contamination, Health**

Pollution of air, water, and soil from agricultural sources is not yet a serious problem in West Virginia, but it is growing. Legislative acts delegating authority for the control of all sources and types of pollutants, including those of agriculture, are vested in several state agencies. The three regulatory agencies of West Virginia which are responsible for enforcing pollution laws are: the State Board of Health, the Department of Natural Resources, and the Air Pollution Control Commission. The State Board of Health supervises and controls the Department of Health and makes and enforces health regulations. This regulation includes dairies, creameries, and slaughterhouses. The Department of Natural Resources administers the Water Pollution Control Act and the Surface Mining Act. The Air Pollution Control Commission administers the Air Pollution Law of West Virginia. In practice, no single regulatory body has sole jurisdiction and responsibility regarding pollution. Each agency's involvement corresponds with its areas of interest. (Merryman-East Central)

2397 - B1, D1, E2, E3 200

## A REVIEW OF METHODS FOR RECYCLING ANIMAL MANURES

**Kentucky University**
**I. J. Ross**
**Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 74-77, 1 fig, 8 ref.**

**Descriptors: *Recycling, *Feeds, *Fertilizers, *Algae, *Fish, *Fermentation.**
**Identifiers: *Manure, *Fly larvae, *Broiler litter, *Refeeding, *Microbes.**

Because the agricultural industry has many critical waste management problems, many new practices and concepts are being tested and researched. Recycling of manures is one such concept. Among the recycling measures considered in this publication are:

(1) Use of manure as fertilizer for plants.
(2) Production of algae in anerobic waste lagoons as a potenitial feedstuff.
(3) Feeding fish diets containing animal manure.
(4) Biodegradation of manure by fly larvae. The end product may then be used as a soil conditioner and a feed supplement.
(5) Use of broiler litter in rations for ruminants.
(6) Fermentation of fresh poultry manure with Rumen microbes to produce high protein feeds. (Merryman-East Central)

2398 - A2, A5, B1, E1, E2 200

## ROLE OF AGRICULTURE IN THE QUALITY OF THE NEW HAMPSHIRE ENVIRONMENT

**Institute of Natural and Environmental Resources**
**New Hampshire University.**
**R. D. Harter.**
**Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p. 78-83. 2 tab.**

**Descriptors: *Agriculture, *Environment, *New Hampshire, *Cattle, *Waste disposal, Lagoons, Swine, Poultry, Water pollution, Odor.**
**Identifiers: *Animal wastes, Oxidation ponds.**

The majority of New Hampshire's land area is too hilly to support an economically viable agricultural operation. A large portion of the remaining area is too wet to farm. Fruit and vegetable farming has been of minor importance. But the steady increase in tourism is encouraging roadside vegetable stands. New Hampshire has a minor animal industry when compared to many states. Sheep are largely confined to the hillier, less populated regions of the state. Hog production is scattered across the state, a few hogs to a farm. Poultry production is nearer populated areas and is often accompanied by odor problems. Waste produced by cattle is roughly equivalent to that produced by the entire human population of the state. Mass waste disposal systems are uneconomical because few dairy herds exceed 100 head, and the majority are less than 30 head. Although oxidation ponds are more acceptable than lagoons, the structure still has generally not been acceptable as a waste disposal method. The New Hampshire Cooperative Extension Service personnel are meeting with farmers and are educating them to the role they must undertake. This service has been the most important single factor in the control of pollution from agricultural sources. (Cameron-East Central).

2399 - B1, E1 200

## REPORT FROM NEW JERSEY

**College of Agriculture and Environmental Science**
**Rutgers University.**
**H. E. Besley.**
**Presented at Conference on Agricultural and Processing Wastes in the Eastern Region: A Perspective, Philadelphia, Pennsylvania, December 1-3, 1970, p 84-85.**

**Descriptors: *New Jersey, *Environmental control, *Waste disposal.**
**Identifiers: *Pollution control.**

Many qualified observers feel New Jersey to be our most urbanized state and they feel that New Jersey has some of the most stringent environmental quality control laws in all the world. As a reflection of New Jersey's concern for the environment, Rutgers University is exerting major research and education in the area of environmental quality. Present and recently completed projects include:

(1) An inventory in four New Jersey counties of the quantity of animal wastes and of the types of disposal methods utilized.
(2) The development of equipment and procedures for disposing of solid and semi-solid organic wastes in the soil.
(3) Utilization of rapid composting as a means of stablizing the wastes resulting from feeding garbage to hogs.
(4) Utilization of organic wastes and silt dredged from streams and waterways to reclaim and increase productivity of abandoned or under utilized lands such as former gravel pits, areas of the pine barrens, etc.
(5) Development of incinerable plastic bottles and utilization of food packages and containers which are more readily disposable than those currently in use.
(6) Research concerning plant responses to air contaminants, such as stack and engine exhaust gases.
(7) Treatment of domestic and industrial wastes to reduce pollution potential. (Merryman-East Central).

2400 - A1, E3 100

## RELATION OF VITAMIN B12 TO THE GROWTH FACTOR PRESENT IN COW MANURE

**Bureau of Animal Industry, Agricultural Research Administration, United States Department of Agriculture, Beltsville, Maryland.**
**R. J. Little, C. A. Denton and H. R. Bird.**
**Journal of Biological Chemistry, Vol. 176, p. 1477-1478, 1948. 1 tab, 2 ref.**

**Descriptors: *Farm wastes, *Growth rates, *Cattle, *Poultry, Bacteria, Injection, Feeds.**
**Identifiers: *Vitamin $B_{12}$, *Manure.**

Crystalline vitamin B12, reported to have activity for chick growth, has been found to be completely effective, either orally or by intramuscular injection, when tested by laboratory method to assay quantities of the unknown growth factor occurring in cow manure, in fish-meal, and in some other feedstuffs of animal origin. The results show that the maximum growth response was the same in two experiments. One experiment used crystaline B12 and the acid precipitate of water extract of cow manure as a dietary supplement. The other experiment used crystalline B12 and 2 units of liver extract. In view of the potency of this vitamin as a bacterial growth factor, the injection experiments are of particular interest since they show that its effect on the chick is direct and not mediated through the intestinal flora. (Cartmell-East Central).

2401 - C1 700

## DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA

**T. M. Midden.**
**M. S. Thesis, University of Kentucky, Lexington, January, 1972, 69 p., 17 fig.**

Descriptors: *Poultry, *Equations, Temperature.
Identifiers: *Excreta, *Drying characteristics, Diameter.

The experiments described in this thesis were designed to determine some of the basic drying characteristics of poultry manures. The specific objectives were: 1. To determine the material constants for and evaluate the usefulness of several drying models for predicting the drying characteristics of formed poultry excreta. 2. To determine the effects of drying air temperature and formed cylinder diameter on the material constants for the most useful model. 3. To determine the time-temperature relationship to form a stable crust on a cylinder of manure. The following thin-layer drying equation was used to describe the fully exposed drying characteristics of formed poultry excreta—MR=e—kt. The effect of drying air temperature on the value of the thin layer drying constant for a particular diameter cylinder can be explained by an Arrhenius type equation—ln k= ln a=—b/R. The effect of cylinder diameter on the value of the thin-layer drying constant for a particular temperature is explained by the exponential equation ln k=ln a+bd. A crust can be formed on the surface of a cylinder of poultry manure when the cylinder is exposed to high temperature drying air. The time required to form a stable cylinder increases with increasing cylinder diameter and decreases with increasing temperature. (Cartmell-East Central).

2402 - B1, D4 100

### BIODEGRADATION OF THE PIG WASTE: BREAKDOWN OF SOLUBLE NITROGEN COMPOUNDS AND THE EFFECT OF COPPER

School of Agriculture, Aberdeen, Scotland, Great Britain.
K. Robinson, S. R. Draper and A. L. Gelman.
Environmental Pollution, Vol. 2, p. 49-56, 1971.
2 fig., 4 tab, 8 ref.

Descriptors: *Waste treatment, *Biodegragation, *Copper, *Nitrogen compounds, Slurries, Rations, Chemical oxygen demand, Aeration.
Identifiers: *Swine.

The presence of large amounts of copper salts in many commercial pit feed supplements represents a potential difficulty in the treatment of pig waste slurries. In view of the fact that copper is known to inhibit the growth of many aerobic bacteria, it is possible that the aerobic breakdown of pit waste might be inhibited if high levels of copper are excreted in the faeces. This was evaluated by examining both the amount of copper excreted and the effect of copper salts on the biodegradation of aliquots of waste, incubated under laboratory conditions. Calculations based on the daily volume of excreta indicated copper concentrations of 750 ppm in the slurry of animals fed on copper supplemental diets. When copper, at different concentrations, was included in pig urine and the liquid aerated, a graded inhibition of the reduction of COD was noted, commencing at 50 ppm and being complete at 500 ppm. (Cartmell-East Central).

2403 - B2, D3, D4 100

### TECHNICAL ASPECTS OF LIQUID COMPOSTING

The DeLaval Separator Company, Poughkeepsie, New York.
L. S. Craurer, and B. Hoffman.
Journal of Milk and Food Technology, Vol. 377 No. 6, p. 293-301, June 1974.

Descriptors: *Dairy industry, *Odor, *Biological treatment, *Liquid wastes, Chemical treatment.
Identifiers: *Composting, *Deodorization.

The DeLaval Separator Company has developed a liquid composting system for deodorizing, pasteurizing, biologically decomposing, and chemically purifying dairy cow waste. The theory of liquid composting and several modes of LITCOM (Liquid Composting) System operation are decribed. Particular emphasis is placed on a description of a completely automated manure handling and treatment system operating at an 80-cow, free-stall dairy barn. Data covering 2 years of operation are presented. (Solid Waste Information Retrieval System).

2404 - A1, B1 100

### CHEMICAL COMPOSITION OF EFFLUENT FROM HIGH DENSITY CULTURE OF CHANNEL CATFISH

Agricultural Experiment Station, Georgia University, Savannah.
J. W. Page, and J. W. Andrews.
Water, Air, and Soil Pollution, Vol. 3, No. 3, p. 365-369, September, 1974.

Descriptors: *Channel catfish, *Fish farming, *Organic wastes, *Animal metabolism, Fish management, Biochemical oxygen demand, Water quality control, Water pollution sources, Analytical techniques, Nitrogen compounds, Waste water (Pollution), Metabolism.
Identifiers: *Metabolic waste products.

Production rates of metabolic wastes by channel catfish (Ictalarus punctatus) were estimated by analyzing effluents from high density culture of 940 g and 60 g catfish. Results were integrated over a 24 h steady-state period in which normal feeding activities were maintained and were expressed as g/day/kg fish and g/day kg feed consumed. When expressed on a unit fish weight basis, production rates were greater for 60 g than for 940 catfish. However, when expressed on a feed consumption basis, production rates of most catabolic products were approximately equal for both size fish. Average values (g/day/kg feed) were as follows: total N, 67; ammonia N, 20; nitrate-nitrite N 20; 5-day BOD, 98; total solids, 180; total P, 15; total K, 18. Filtered solids from effluent contained 5% nitrogen, 1.0% phosphorous and .13% potassium. Diurnal variation in production rates were noted with solid production reaching maximum after each feeding and BOD, NH3, and nitrate reaching a maximum only in the afternoon. (Katz).

2405 - A2, D4 700

### SOIL ADSORPTION OF HUMIC COLOR

Department of Civil Engineering, Nebraska University, Lincoln.
R. A. Miller.
MS Thesis, Nebraska University, Lincoln, May 1974, 49 p. 10 fig, 5 tab, 22 ref.

Descriptors: *Color, *Feedlots, *Adsorption, *Chemical oxygen demand, *Waste water treatment, Sands, Waste disposal, Biological treatment, Runoff, Water quality, Soils, Design criteria, Farm wastes.
Identifiers: *Soil adsorption beds.

The degradation of receiving streams and lakes has prompted many studies on the treatment of feedlot runoff. Various biological treatment systems have been developed to reduce organic strength levels; however, economic color reduction has not been obtained. The main purpose of this study was to evaluate color reduction of feedlot runoff by the process of soil adsorption. Significant reductions in chemical oxygen demand were also anticipated. Conclusions are as follows: (1) color and COD removal from biologically treated feedlot runoff can be obtained by adsorption on clayey fine sand; (2) reduction of color and COD using soil beds is an effective, economical technique for disposal of biologically treated feedlot runoff; and (3) loading rates of 2 inches per day or less and depths of 5 feet or more should be used as design criteria for soil adsorption beds operating full. (Selected Water Resources Abstracts).

2406 - A1, B1 700

### EFFECT OF ANTIBIOTIC SUPPLEMENTATION ON THE DECOMPOSITION OF ANIMAL WASTES

F. K. Elmund.
MS Thesis, Colorado State University, Fort Collins, March 1970, 42 p., 3 fig, 6 tab, 18 ref.

Descriptors: *Antibiotics, *Degradation, Cattle, Feedlots, Microorganisms.
Identifiers: *Manure, *Chlortetracycline, Pollution.

Experiments were conducted to evaluate the possible presence and role of metabolic inhibitors in excreted wastes of cattle which had ingested chlortetracycline. It was felt that alteration of the decomposition process might increase the potential pollution hazards of these excreted wastes. The results of these studies suggest that antibiotic supplementation of animal feeds selects for a microbial population relatively inefficient in the stabilization process. In addition, ingested antibiotic apparently alters the digestive processes in the animal, producing excreted wastes which are less biodegradable. (Cartmell-East Central).

2407 - A1, B1, D4, E2 300

### FARM WASTE DISPOSAL

United Kingdom Ministry of Agriculture, Fisheries and Food.
United Kingdom Ministry of Agriculture, Fisheries and Food. Short Term Leaflet 67, Amended 1973, 24 p. 4 tab.

Descriptors: *Waste disposal, *Waste treatment, *Aerobic conditions, Effluent, Anaerobic digestion, Livestock, Legal aspects, Pathogenic bacteria, Irrigation.
Identifiers: *United Kingdom, *Farm wastes, *Land disposal.

When planning a waste disposal system it is important to know how much and what kind of material will have to be handled. There are basically 5 systems of manure handling: (1) solid, (2) semisolid, (3) liquid slurry, (4) organic irrigation, and (5) discharge into a public sewer. Aerobic oxidation treatment systems include (1) the oxidation ditch, (2) the high rate biological filter tower and (3) the surface aerator. In addition to manure, silage effluent; washing down water; rainwater; and other water used in the milking process must be considered when designing farm buildings. In utilization of farm manure, it is normally recommended that diluted cow slurry (1 part manure: 2 parts water) should be applied at up to 15,000 gal. per acre per annum in three separate applications. The legal aspects of waste disposal are clarified by the Rivers Act of 1951 and 1961, the Water Resources Act of 1963, the Public Health Acts of 1961 and 1969, and the Agricultural Act of 1956. Infectious organisms of concern are the salmonella group of bacteria and brucellosis. The proper waste disposal system for a particular farm is dependent upon the type of land, acreage and cropping policy, type of housing, scale of enterprise, costs, river pollution, nuisance and health possibility of hazards, and comfort of stock and men. Care should be taken not to: agitate or empty storage tanks when the wind direction will carry smells to houses, operate spray guns in periods of high wind, irrigate when the land is saturated, or drain effluent directly into a water course. (Battles-East Central).

2408 - A1, A2, B1, C2, C3, D1, E1, F1 100

### REVIEW PAPER: ANIMAL WASTES MANAGEMENT AND CHARACTERIZATION

Division of Environmental Engineering, College of Engineering, Utah State University, Logan.
J. E. Middlebrooks.
Water Research, Vol. 8, p. 697-712, 1974. 1 fig. 13 tab, 46 ref.

Descriptors: *Farm wastes, *Physical properties, *Chemical properties, *Agricultural runoff, *Waste treatment, *Nutrients, *Feedlots, *Confinement pens, *Locating, Lagoons.
Identifiers: *Waste management, *Land disposal, Retention ponds.

Agricultural related environmental quality problems have received little attention until the last 10 years. The purpose of this report is to attempt to provide an overall picture of the characteristics and treatability of animal wastes and runoff from animal feedlots. The study showed that there is a wide variability in both the characteristics and performance of treatment facilities. Loehr (1972) proposed several feedlot runoff control measures, such as retention ponds, use of evaporation ponds, diversion, land disposal of the excess liquid and accumulated solid matter, confinement, and proper location. All of the above methods can easily be adapted to fit a particular situation under certain environmental conditions. Application of one or all of these methods depends on such factors as rainfall patterns for a particular area, rainfall amount and frequency, and geography. Location selection is possibly a key in the control of feedlot and animal waste pollution. Another significant factor in controlling feedlot and animal waste pollution is the number of waste management alternatives that are made available to a feedlot operator. However, it appears that the agricultural industry is incapable of absorbing the costs of conventional waste treatment at this time. Therefore, whenever possible, feedlot location should be such that the old reliable method of confinement and land disposal can be employed. (Penrod-East Central).

2409 - D3 700

## CHEMICAL COAGULATION OF FEEDLOT RUNOFF

R. J. Smana.
MS Thesis, Department of Civil Engineering, University of Nebraska, May, 1972, 60 p., 25 fig. 7 tab, 23 ref.

Descriptors: *Feedlots, *Agricultural runoff, *Chemicals, *Coagulation, *Costs, Turbidity, Sludge.
Identifiers: *Color reduction.

This investigation was undertaken to evaluate the treatment of feedlot runoff by chemical coagulation, with color reduction as the prime goal. The removal of organic material and other desirable effects were also anticipated. Alkalinity was shown to be important in the chemical coagulation process. Turbidity and apparent color can be reduced by the application of moderate amounts of coagulants, whereas the colloidal color, believed to be hydrophilic, requires large coagulant dosages for significant removal. The reduction of the total solids, suspended solids and COD may be related to the reduction of turbidity. Feedlot runoff can be clarified by coagulation using the common metalic coagulants. Estimated chemical costs of such treatment are in excess of $1.00 per 1000 gallons. From the chemical costs involved and the large volume of chemical sludge produced, chemical coagulation does not appear to be a practical method of treating this waste. (Cartmell-East Central).

2410 - A1, B2, D4 100

## SOLIDS REDUCTION OF BEEF CATTLE WASTES IN A SEMIBATCH-PROCESS OXIDATION DITCH

Area Livestock Specialist, Fort Dodge, Iowa.
B. B. Berven, M. P. Hoffman, H. L. Self, and S. W. Melvin.
Transactions of the ASAE, Vol. 18, No. 2, p. 316-318, 322, March-April, 1975. 1 fig. 4 tab. 7 ref.

Descriptors: *Waste treatment, *Cattle, *Confinement pens, *Energy, Microbial degradation.
Identifiers: *Oxidation ditch, *Semi-batch process, *Solids reduction.

The potential pollution problems from the livestock feeding industry and the development of greater concern for the environment are forcing many cattle feeders to look for better methods of controlling the waste from feeding facilities. The objective of this study was to evaluate solids reduction of beef wastes in a semi-batch-process oxidation ditch of a cold confinement facility with slotted floors. Data on solids-reduction were obtained from two test periods. The first period was from November 10, 1971, to April 12, 1972 and the second was from April 28, 1972, to October 4, 1972. Two procedures were used. The first procedure assumed that the daily dry matter waste production per steer was 2.3 kg and total solid-reduction values of 32.6 and 33.0 per cent were obtained for winter and summer tests, respectively. The concept of the partitioning of energy in feedstuffs was employed in the second procedure. The total solids-reduction values of 28.1 and 27.2 per cent were obtained for the winter and summer tests, respectively. Tables are provided which show ration composition, and total solids reduction for both procedures. A schematic diagram of components of energy utilization and loss is also given. (Penrod-East Central).

2411 - A2, A3, B1 300

## SURFACE RUNOFF IN DAIRIES

Department of Soil Science and Agricultural Engineering University of California, Riverside.
A. C. Chang, D. Aref, and D. C. Baier.
California Agriculture, Vol.29, No. 4, p. 16-17, April, 1975, 2 fig., 2 ref.

Descriptors: *Agricultural runoff, *Dairy industry, *Water pollution, *California, *Watersheds, *Hydrology, *Precipitation, Suspended solids.

Surface runoff usually carries a high water pollution potential if it comes from livestock-manured areas. In an area such as the Chino-Corona dairy preserve, which has a heavy concentration of livestock, manure-laden runoff could be a significant portion of the total surface runoff of the watershed and could degrade the quality of the receiving stream. The purpose of this study was to attempt to determine the hydrologic and water quality characteristics of surface runoff from this area. Researchers simulated precipitation on the surface of dairy corrals where animals are confined, rather than wait for runoff generating storms. A table is provided which summarizes the hydrologic characteristics of each delivered precipitation and its resultant runoff. The transport of suspended solids by overland flow did not appear to be a serious problem on mildly-sloped land, although the loss of dissolved minerals to surface runoff was significant. Channels have a tendency to be formed by overland flow traveling a long distance; this channelled flow with higher velocity would transport larger amounts of loosely-packed wastes. No channel was formed under experimental conditions. This information leads to the conclusion that a well-sloped corral surface would minimize the loss of suspended material through runoff. (Penrod-East Central).

2412 - A1, A5, B2, D4 100

## A STUDY IN A FULL-SCALE SWINE WASTE DISPOSAL SYSTEM

Institute of Environmental Sciences and Engineering, Toronto University, Canada.
P. H. Jones and N. K. Patni.
Water Research, Vol. 6, p. 1425-1432, 1972. 8 fig. 1 tab. 4 ref.

Descriptors: *Waste treatment, Biochemical oxygen demand, Chemical oxygen demand.
Identifiers: *Swine, *Oxidation ditch, *Ditch mixed liquor, Organic carbon, Odor control.

A problem of disposal of large amounts of animal wastes arises when confinement livestock breeding is utilized. This problem is especially great since there is an increasing trend towards this method of breeding and the problem is magnified when land application of the manure produced is not feasible. Because of their simplicity and economy, oxidation ditches are being considered more often as a means of partially or completely stabilizing livestock wastes. The objective of this study was to report findings on the biological efficiency of oxidation ditches in reducing organic carbon. This study showed that the oxidation ditch was a satisfactory unit for treating swine wastes for the reduction of BOD and COD loads. If the manure is mixed with poorly biodegradable bedding material, it is desirable to screen the wastes for large solid materials before introducing them into the ditch. It was advised that foaming be considered in the design of a unit, particularly when in-the-building oxidation ditches under slatted floors in the pens are used, as excessive foaming was often a serious problem. For odor control, better DO distribution in the entire ML mass is desirable. Two methods of achieving this are using extra rotors or using direct air injection into the ditch ML. (Penrod-East Central).

2413 - A1, B1 100

## SUBSURFACE DISTRIBUTION OF NITRATES BELOW CHEMICAL CATTLE FEEDLOT, TEXAS HIGH PLAINS

Department of Geosciences, Texas Tech University, Lubbock.
W. D. Miller.
Water Resources Bulletin, Vol. 7, No. 5, p. 941-950, October, 1971. 5 fig, 2 tab, 3 ref.

Descriptors: *Feedlots, *Infiltration, *Nitrates, *Texas, *Groundwater pollution, *Agricultural runoff, Permeability, Ponds, Waste storage.
Identifiers: Subsurface distribution.

For several years, speculation has been rampant concerning the potential pollution hazard of commercial cattle feedlots to groundwater zone (Ogallala Formation) of the Texas High Plains. The major objectives of the study were: (1) determination of quantitative distribution of nitrogen and other chemical parameters below major feedlots, (2) evaluation of laboratory and field determined rates of nitrate movement from surface to watertable, (3) determination of the time-space distribution of ions in the saturated zone, and (4) the determination of what geologic environments in the High Plains are least conducive to infiltration of cattle feedlot runoff. Water samples were collected for quality analyses from beneath eighty commercial cattle feedlots in the Texas High Plains. The establishment of vertical gradients of dissolved solids was determined from the drilling and/or coring of twenty-two feedlots. Lots included in the study ranged in age from new installations to 35 years. Runoff collection-systems on lots include playas, dammed and undammed stream channels, and man-made ponds. Infiltration to the watertable below feedyards of feedlot liquid waste is insignificant in most localities of the Texas High Plains. Infiltration of "collected" feedlot runoff and subsequent concentration of dissolved ions in groundwater in the High Plains is dependent upon several factors. These factors are listed and discussed by the author. The study showed that certainly, no regional subsurface pollution problem exists today nor is one foreseen from cattle feedlot runoff in the Texas High Plains. (Penrod-East Central).

2414 - A5, A9, B1 300

## POULTRY MANURE: ITS PRESERVATION, DEODORIZATION AND DISINFECTION

New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey.
W. Yushok and F. E. Bear.
New Jersey Agricultural Experiment Station Bulletin No. 707, Rutgers University, 1948, 11 p. 8 ref., 7 tab.

Descriptors: *Poultry, *Farm wastes, *Preservation, *Disinfection, *Waste treatment, Ammonia, New Jersey, Fertilizers, Nitrogen, Drying, Costs, Bacteria.
Identifiers: *Deodorization, Superphosphate, Hydrated lime.

Conservation is an important word on the poultry farm. This calls for prevention of waste and the preservation of the health of the flock. The purpose of this report was to attempt to solve problems which deal with the handling of poultry manure. They are: (1) the product tends to lose much of its value, (2) it attracts flies and rodents, (3) it gives off disagreeable odors, and (4) it is a potential source of disease. Calculations made from the study data showed that 81 per cent of the N, 88 per cent of the phosphoric acid, and 95 per cent of the potash fed to hens are excreted in the manure. The contents of fresh manure produced by laying hens was found to be about 78 per cent moisture, 1.05 per cent N, 0.83 per cent phosphorus acid, and 0.51 per cent potash. A large percentage of nitrogen in untreated poultry waste was lost as ammonia, especially in warm weather. The most effective agent used in preventing the loss of nitrogen from poultry manure was superphosphate. At least 100 pounds of superphosphate should be added to one ton of fresh manure. Manure can be preserved by artificial drying, but this causes a loss of nitrogen, regardless of treatment with preservatives. Costs of dried product production are given. Hydrated lime was found to be the most effective deodorizer of poultry manure, also having a marked effect in reducing nitrogen losses from fresh manure. The addition of hydrated lime also improved the handling qualities of the product. Application rates of lime are provided. Hydrated lime was found to have bactericidal effect on paratyphoid, pollorum, typhoid, and fowl cholera organisms and it prevented coccidial parasites and large-roundworms' eggs from reaching infective stage. (Penrod-East Central).

2415 - A1, B1, E1, E2, E3 400

### CRITICAL WASTE PROBLEMS AHEAD

Kentucky University.
I. P. Ross, B. J. Barfield, and H. E. Hamilton.
Livestock Breeder Journal, Vol. 15, p. 270-272, 274, July, 1972.

Descriptors: *Agricultural wastes, *Waste disposal, Lagoons, Recycling
Identifiers: *Livestock wastes, *Waste management, *Pollution, Land disposal, Oxidation ditches.

Agricultural waste management problems have been magnified by recent developments—extension of the suburbs into farming areas, centralization of animal producing facilities, increased production, use of chemical fertilizers and demand for processed food. Many new practices and concepts are being tested and researched in an effort to solve these problems. Livestock waste pollution constitutes about 11 per cent of all agricultural pollution. Land disposal of these wastes is the most widely used disposal method. Microbial digestion systems such as lagoons and oxidation ditches rank second. Other systems include: dehydration to produce fertilizers, deep dispersal into drilled wells, and various methods of recycling. In summary, Theodore C. Byerly of the U.S. Department of Agriculture warns us, "As we attempt to resolve the problems of pollution, the systems we choose must not only be technologically effective, but also socially and economically acceptable." (Merryman-East Central).

2416 - A1, B3, D3, E2 400

### POULTRY MANURE COMPOSTING

J. M. Sweeten.
Fowl Tips Newsletter, Vol. 2, No. 4, p. 2-3, 1973.

Descriptors: *Aeration, *Forced drying, Thermophilic bacteria, Moisture content, Temperature.
Identifiers: *Composting, *Windrows, pH, Carbon-nitrogen ratio, Land disposal.

Composting of manure and litter before disposing of it on the land improves the wastes' handling characteristics, preserves nitrogen, and reduces odors and flies during storage and disposal. The objective of composting is to provide the ideal diet and environment for thermophilic bacteria. Proper aeration, moisture content, temperature, pH, and carbon-nitrogen ratio are critical. To reduce moisture content, improve aeration, increase carbon-nitrogen ratio, and reduce oxygen requirement, carbonaceous wastes (litter, sawdust, crop residues, etc.) may be added to manure. Initial pH should be 6.5 to 7.2. Final pH values will range from 8.5 to 9.0. Aeration is a key factor in composting. If forced air injection is used, initial aeration rates of 2.0 to 5.0 cubic feet of air per minute per cubic yard of compost (cfm/cu. yd.) should be provided in the beginning, with reduction to 1.0 cfm/cu. yd. during the third week, and with no further aeration needed after the fourth week. If windrows are used for composting, they should be no more than three feet high and should be turned at least three times a week for the first two weeks after the compost has heated to above 113 degrees F. Turning may be reduced to once a week during the next week or two. Turning may be terminated whenever the compost fails to regain a temperature in excess of 113 degrees F. The compost should then be aged in stockpiles for 60 days. (Merryman-East Central).

2417 - A1, B1, E2 400

### SOLID WASTE HANDLING

Pennsylvania State University.
A. R. Grout.
Dairy Herd Management, Vol. 11, No. 4, p. 12-13, 1974.

Descriptors: *Solid wastes, *Slurries, *Dairy industry, *Waste storage, *Storage tanks, *Storage requirements.
Identifiers: *Waste management, *Land disposal, *Stackers, *Free stall barns, *Manure ponds.

While processes such as dehydration, composting, and recycling into methane are being used on manure, the best bet for most dairymen is the use of cropland as the processing medium. This generally means that manure has to be stored until proper time for land disposal. Long elevators or mechanical throwing devices are needed for stall barn manure because it will not flow. Different methods for water removal from the manure are discussed. The manure itself is transported to a stacker enclosure which, in most cases, is built of reinforced concrete. Storage capacity is figured at 1.5 cu. ft. per 1,000 pound animal unit. Capacity of storage is usually planned for a period of six months or more. Roofs over these structures are optional but desirable. Manure storage for free stall barns is stored "as produced" as a heavy slurry with very little added bedding material. The free stall barn can be cleaned with a tractor scraper or by the new automatic scrapers. Conveyance to the storage basin can be by gutter cleaner chain, or by pushing the manure through an underground pipe with a special ram pump. The storage enclosure for this type manure is usually built below ground level with reinforced concrete walls on three sides. One end has a sloped entrance floor up to the wall level which allows manure to be brought up the ramp with a tractor loader. The spreader can be backed into the basin as the level recedes due to manure removal. Use of manure ponds with earth walls like a farm pond is also gaining acceptance for storage of this type of manure slurry. (Merryman-East Central).

2418 - A5, B1, E2, E3 400

### CHINO VALLEY SHAKER

Dairy Herd Management Editor.
G. Ashfield.
Dairy Herd Management, Vol. 11, No. 4, p. 22-27, April, 1974. 7 fig.

Descriptors: *Dairy industry, *California, *Fertilizers, Odor, Sprinkler irrigation.
Identifiers: *Waste management, *Storage pond, *Land disposal, *Bedding.

Manure is neither an asset nor a liability but simply one of two products of the more than 700 dairy animals housed at the C. S. Musser & Sons, Inc., producer-distributor dairy operation. The waste collection and handling program is organized with all the care and planning normally reserved exclusively for the prime dairy product, milk. In full cycle, the manure is flushed, pumped, separated, and stored in both solid and liquid form prior to its use as bedding and fertilizer. An intensive 13 month study was conducted to evaluate the workings of the waste retention pond. Specific goals of the study were to determine: (1) the effect of dairy waste as a pond sealant; (2) the chemical and biological action in, around and under the pond. The waste pond became effectively sealed from excess infiltration in not more than 55 days after inflow of screened dairy sewage. Odor emissions from the pond were not severe enough to create a neighborhood nuisance and the pond did not create a fly problem. Sufficient acreage of irrigated cropland to permit effective pond management and post-pond discharge of the contents is essential to make this type of pond and the accompanying waste disposal environmentally acceptable. (Cartmell-East Central).

2419 - A9, B1, E3 100

### ENSILED BROILER LITTER AND CORN FORAGE. 1. FERMENTATION CHARACTERISTICS

Department of Agriculture, Maryland University, Eastern Shore Princess Anne.
B. W. Harmon, J. P. Fontenot and K. E. Webb, Jr.
Journal of Animal Science, Vol. 40, No. 1, p. 144, January, 1975. 10 tab, 29 ref.

Descriptors: *Feeds, *Poultry, *Fermentation, *Litter, *Coliforms, *Pathogenic bacteria.
Identifiers: *Refeeding, *Ensiled broiler litter, Food and Drug Administration, Corn forage.

Broiler litter is an accumulation of poultry excreta, feathers, wasted bedding and feed and is valuable as a feed for ruminants. The Food and Drug Administration does not sanction the practice of recycling broiler litter by feeding. There is apprehension concerning the dangers of pathogenic organisms in litter fed to livestock, although no serious health problems have resulted from feeding broiler litter. The objective of this study was to determine the feasibility of ensiling broiler litter and corn forage. This study gives the fermentation characteristics and microbial population studies of mixtures of different ratios of broiler litter and corn forage cut at two stages of maturity. All mixtures appeared to show typical fermentation characteristics and preserved well. By advancing maturity of corn forage and by each level of litter addition, the per cent dry matter in silage was significantly increased. The crude protein content of the silage was significantly increased by the addition of litter. The total bacteria counts of the silages exceeded 3 million bacteria per gram. The coliform population was generally higher for the control silages than for the silages containing litter. This trend for lower coliform numbers in litter silages than controls suggests that ensiling may be an economical means of eliminating potential hazards from the possible presence of pathogens in litter. Tables on mixture composition, total and ammonia nitrogen, fermentation characteristics, and the total count of bacteria and coliform for the various small and large-bag silages are given. (Penrod-East Central).

2420 - A9, B1, E3 400

### CANADIANS EXPLAIN ADVANTAGES, PROBLEMS IN FEEDING POULTRY LITTER

Feedstuffs, January 7, 1967, p. 46.

Descriptors: *Feeds, *Poultry, *Litter, *Canada, Proteins, Nutrients, Pathogenic bacteria.
Identifiers: *Refeeding, Broilers, Layers, Alberta.

A report made by the Alberta Department of Agriculture on feeding poultry litter is discussed. The report discovered that poultry litter analyses indicate a wide variation between samples. Reasons were most probably whether litter came from layers or broilers, the kind and amount of bedding used, amount of weathering or heating and management factors such as wastage, feed, etc. The study showed that the amount of bedding used is more important than the type of bedding. Using more bedding resulted in lower protein. Some generalizations on litter feed were given. Some of them are: (1) Vitamin D and A will require supplementing, (2) fiber content is not excessive, (3) nitrate levels on these samples, at least, were considerably below the 1.5 per cent danger level, however, this is one point where more information could be of value. The Department of Agriculture reported that disease hazards (salmonellosis, coccidiosis, and avian TB) are of some concern in litter feeding, but do not seem to provide major obstacles. The decreased cost of the litter ration is the cause for the enthusiasm for feeding litter rather than the increased gains. Keeping the litter and/or the mixed feed from heating up was a real problem, the Alberta operators agreed. Other problems and advantages are given. The Alberta report showed that the normal method of feeding litter is to hammer together a mixture of litter and grain. (Penrod-East Central).

### 2421 - A1, B1, E1, F2 300

## WHOSE RESPONSIBILITY? CONTROL OF LIVESTOCK AND POULTRY WASTES

**Michigan State University.**

**Draft No. 3, Agricultural Engineering Department and Cooperative Extension Service, Michigan State University, August 4, 1971. 10 p.**

**Descriptors: *Waste disposal, *Legal aspects, *Michigan, *Livestock, *Poultry.**
**Identifiers: *Waste management, *Pollution, *Land disposal.**

The purpose of this study is to provide information on pollution and pollution control for livestock wastes. Pollution is defined in terms of Michigan Law. There are several common agricultural pollutants. The major causes are animal odors and wastes, soil sediment and agricultural chemicals. Other pollution sources are fuels, soil particles, dead animals, noise, trash, smoke and garbage. Water pollution potential of animal wastes is defined in terms of (a) organic oxygen consuming characteristics, (b) bacteriological quality, (c) suspended solids, and (d) nutrients. The various Michigan state agencies and their functions and responsibilities are discussed. Agencies and departments from which farmers can obtain various financial assistance are listed. Some conditions which greatly increase the potential of pollution by livestock or poultry wastes are given. Among them are: (1) a major livestock facility expansion, (2) spreading of wastes on frozen ground, and (3) high concentrations of livestock or poultry. General good rules to follow for land application are given. Alternate methods of disposal are given. The report states that the farm operator is responsible for making sure that pollution does not result from his farming operation, and gives ways in which he can avoid pollution. Site selection and land area for waste disposal are two important considerations when planning an operation expansion. The report gives the acceptable systems that are now available for disposing of animal wastes and lists other sources of agricultural pollution. (Penrod-East Central).

### 2422 - A5, A6, B1 100

## WEATHERING OF ACCUMULATED WASTES IN UNROOFED AND UNPAVED CONFINED LIVESTOCK OPERATIONS,

Department of Soil Science and Agricultural Engineering, California University, Riverside.
A. C. Chang and D. S. Adriano
Journal of Environmental Quality, Vol. 4, No. 1, p. 79-82, January-March, 1975. 4 fig., 2 tab, 16 ref.

Descriptors: Confinement pens, Farm wastes, Weathering, Cattle, Dairy industry, California, Chemical properties, Physical properties
Identifiers: Waste decomposition, Waste distribution

Animal waste may accumulate on the ground surface several months in an open, unpaved livestock confinement prior to collection and disposal. A beef and a dairy cattle confinement operation were sampled after 2 months of waste accumulation to determine waste accumulation patterns and the effect of natural weathering on the characteristics of deposited wastes and waste stability. The study ascertained that 50 percent of the total waste produced was concentrated in 25 percent of the surface area. Moisture content of waste from the beef cattle feedlot is usually higher than that from the dairy lot. Stability of the waste measured as TN/FS or as COD/FS, indicated there was only 15-20 percent decomposition of waste during the 2 months' accumulation. The samples collected, however, indicated the accumulating waste was unstable and would undergo further decomposition at a suitable environmental condition. Between the two confinement units, there appeared to be little difference in the weathering of accumulated wastes. This was attributed to the management operations of the two units. (Penrod-East Central)

### 2423 - E2

## VALUE OF MANURE ON AN IRRIGATED CALCAREOUS SOIL,

Kansas Agricultural Experiment Station, Kansas State University, Garden City.
G. M. Herron and A. B. Erhart
Soil Science Society of America Proceedings, Vol. 29, p. 273-281, 1965. 7 fig, 3 tab, 17 ref.

Descriptors: Nutrients, Nitrogen, Phosphorus, Grain Sorghum, Yields.
Identifiers: Manure, Land application, Soil fertility

Quality is important when manure is sold as fertilizer rather than disposed of as waste material; yet, little if any emphasis is placed on manure "quality." The objective of this study is to attempt to evaluate "high quality" manure in comparison to commercial fertilizer. Data from such a study should help determine the economy of manure disposal and or use. The study showed that each ton of high quality manure was equivalent to 22 lb. of nitrogen from ammonium nitrate as measured by equivalent grain sorghum (Sorghum vulgare Pers.) yields over a 4-year period. When both manure and N were applied, maximum yields were attained. The relative yield of grain correlated better with nitrogen removed in the grain than nitrogen removed in total above-ground portion of the grain sorghum plant. Based on the results of the study, high quality manure could be valued at about two-thirds to three-fourths of its total N content for sorghum production. On soils that need P, K, trace elements, or improved physical condition, some additional value would be justified. Using the Bray and Kurtz no. 1 procedure, the phosphorus level of the soil was increased by 1 ppm for each ton of applied manure. (Penrod-East Central)

### 2424 - A5 100

## VOLATILIZATION OF NITROGEN-CONTAINING COMPOUNDS FROM BEEF CATTLE AREAS,

U. S. Department of Agriculture, Lincoln, Nebraska
L. F. Elliott, G. E. Schuman, and F. G. Viets, Jr.
Soil Science Society of America Proceedings, Vol. 35, p. 752-755, 1971. 4 fig, 2 tab, 10 ref.

Descriptors: Feedlots, Cattle, Pastures, Odor, Ammonia, Nitrogen compounds, Sampling, Soil temperature.
Identifiers: Volatilization, Steam distillation, Amines, Mounding.

Volatile N-containing compounds are found in chicken and swine manure and some or all of these compounds probably volatilize from cattle manure, along with $NH_3$, and contribute to odor. The object of this study is to determine the distillable and nondistillable nitrogen that contributes to odor from feedlots. The release of steam-distillable organic N compounds and $NH_3$ to the atmosphere from a small beef feedlot and a pasture was measured. Study data indicated that the quantities of distillable N being released were increased by surface disturbance such as mounding. Results also indicated that ammonia evolution is soil temperature-dependent, $NH_3$ volatilization increasing with increased temperatures in the spring. Throughout the year, distillable N trapped in the cropland was much less than that trapped at the feedlot site. The yearly average values were 148 kg/ha per year for the acid trap next to the feedlot and 16 kg-ha per year for the cropland trap, a significant difference at the 5 per cent level as determined with the F Test. The same traps averaged 21 and 3.3 kg/ha per year, respectively, of organic N compounds that weren't recovered in a 3-minute steam distillation procedure. Tests showed that although most amounts were too low to be measured accurately, some aliphatic amines were present in the trapping solution. (Penrod-East Central)

### 2425 - D1, E3, F1, F2 400

## UTILIZING WASTES IN ANIMALS FEEDS–A EUROPEAN OVERVIEW,

Agricultural Research Council's Poultry Research Center, Edinburgh, Scotland
R. Blair
Feedstuffs, Vol. 47, No. 26, p. 16, 33-34, 44, June 30, 1975. 6 tab, 16 ref.

Descriptors: Recycling, Organic wastes, Europe, Legislation, Proteins, Cellulose, Farm wastes, Industrial wastes.
Identifiers: Refeeding, DPW, Single-cell protein, Hydrocarbons.

There are two main incentives for waste recycling to aid in pollution abatement. One is that wastes might safely be recycled for refeeding and the other is that it might be a profitable enterprise for the sector of the industry concerned. Even though there is a need for increased use of indigenous proteins, animal foodstuffs quality is governed by legislation. Legislation differs within the European Economic Community (EEC) and harmonization is not expected to take place for a few years. The legislation of several countries within the EEC is briefly discussed. Various changes in these legislations are also examined. The systems for drying which can give a possible profit incentive are given. The use and processing of straw, wood and other cellulosic wastes for use in animal foods is explained, along with possible drawbacks. Industrial wastes that are dealt with in the capacity as possible food supplements for animals are: (1) spent liquor left after the fermentation of alcohol, yeast, citric acid and other products, using molasses as substrate and organisms such as yeasts or Aspergillus niger, and (2) coffee pulp, hulls and grounds. These wastes can be processed directly for inclusion in animal feed but another approach is to use them as substrates for single-cell protein SCP production. One of the most promising sources for this type of production is the suphite liquor from large paper mills. The use of hydrocarbons in SCP production is examined. However, the use of hydrocarbons is more expensive in SCP production than the use of wastes. (Penrod-East Central)

### 2426 - A1, D1, E2 300

## USE OF SLUDGE RELIEVES 'FERTILIZER SHORTAGE'.

Ecosystems, Vol. 5, No. 7, p. 7, April, 1975.

Descriptors: Recycling, Energy, Fertilizers, Sludge disposal, Municipal wastes, Feedlots, Delaware, Maine, Missouri.
Identifiers: Shredding, Composting, Land disposal.

According to EPA administrator Russell E. Train, the 120 per cent price rise in commercial fertilizers since 1973 may make the use of organic material such as municipal sludges and feedlot wastes an economic necessity in the future. However, not all sludges could be used for soil improvement because in some cases the waste might contain excessive concentrations of viruses or metals that could be hazardous to health. A demonstration project in Delaware will include compost production and facilities to enrich the product with synthetic fertilizers. The project will test the concept of plowing under shredded solid waste and sewage sludge for soil enrichment. Marketing value will also be explored. A demonstration project is also being set up in Maine to demonstrate a new and simple sludge composting technology developed by the Department of Agriculture. One other EPA-supporting demonstration project will be an energy recovery system in St. Louis. This system shreds the waste and separates the organic from the inorganic materials. Both materials are now being used for energy production because of the heavy demand for energy, although the organics could be used in soil conditioning if demand warranted. Mr. Train concluded that now is perhaps the time to change old tendencies toward the disposal and destruction of residuals and waste. (Penrod-East Central)

### 2427 - E3 100

### USE OF DRIED POULTRY WASTE IN DIETS FOR CHICKENS,

Department of Animal Science, Iowa State University, Ames 50010
N. Trakulchang and S. L. Balloun
Poultry Science, Vol. 54, No. 2, p. 609-614, March, 1975. 8 tab, 10 ref.

Descriptors: Diets, Performance, Amino acids, Proteins.
Identifiers: Poultry, DPW, Broilers, Laying hens, Nitrogen utilization, Egg production, Feed conversion efficiency.

The purpose of this study was to determine whether DPW could be utilized as a beneficial feedstuff by chickens. Two experiments with broiler chicks and one with laying hens were utilized in examining the effects of dried poultry wastes on poultry. Experiment 1 indicated that DPW at 10 per cent, without amino acid supplementation, did not affect weight gains and feed efficiency of young chicks, but 20 per cent DPW without added amino acids greatly depressed growth and feed efficiency. The experiment further indicated that supplemental amino acids contributed more utilizable nitrogen to the DPW diets. Experiment 2 revealed that DPW at 10 per cent of the diet, with true protein maintained at 22 ± 0.5 per cent, did not significantly affect weight gains or field efficiency. Experiment 3 showed that for laying hens, beyond their peak of production, DPW decreased rate of egg production and efficiency of feed conversion and increased mortality. (Penrod-East Central)

### 2428 - A6, A9, B2 300

### UNDERFLOOR VENTILATION FOR SLOTTED FLOOR SWINE BUILDINGS,

Department of Agricultural Engineering College of Agriculture, Illinois University, Urbana-Champaign
A. J. Muehling
Agricultural Engineering Tips, Farm Buildings No. 35, December, 1974, 5 p. 2 fig, 3 tab.

Descriptors: Ventilation, Design, Carbon dioxide, Ammonia, Hydrogen sulfide, Methane.
Identifiers: Air inlets, Louvers, Fans, Slotted floors, design formula.

The four main gases produced by manure stored in a tank or pit are ammonia, methane, carbon dioxide and hydrogen sulfide. The amount of gas produced depends on the length of time the manure is in storage, the volume of manure involved, its temperature, and other factors. In terms of the amount of gas released into the building, the amount of mixing or agitation is a very important factor. There is some concern regarding the long-range effect on operators and small pigs that spend long hours in swine production facilities that use pits or tanks. Proper ventilation is felt to be important to their health. The amount of ventilation usually depends upon the weather (among other things). The main purpose of winter ventilation is for moisture and odor control. The primary purpose of ventilation in the summer is to control the building temperature. The requirements for an underfloor ventilation system are listed. The various components of the system are discussed. Air inlets should distribute the air uniformly through the building. The purpose of louvers is to allow the air to enter the attic. A central duct permits uniform ventilation throughout the buildings. Properly sized openings from the pit to the duct allow the air to flow uniformly from the pit into the central duct. The placement, controls and types of fans are discussed. The report concludes with a design example in calculating the underfloor ventilation needed. (Penrod-East Central)

### 2429 - A1, B2, D4, E1, F2 400

### RACEWAYS; EXOTIC SPECIES MOST AFFECTED BY PROPOSED E.P.A. DISCHARGE PERMITS,

Associate Professor, School of Forestry and Wildlife Management, Louisiana State University.
D. D. Culley, Jr.
The American Fish Farmer, Vol. 4, No. 8, p. 9-12, July 1973.

Descriptors: Regulation, Permits, Waste water pollution, Fish farming, Lagoons, Filtration, Recirculated water.
Identifiers: Non-native fish.

The proposed amendment of Part 125, Title 40 of the Code of Federal Regulations will affect the licensing control of pond and raceway aquaculture facilities discharging wastes more than 30 days yearly and of non-native aquatic animal productions. Raceway facilities having continuous discharge would require licensing or converting to recirculating filtration or lagoon holding systems. A permit system should serve as an incentive for aquaculturists to become more efficient in their operations. There is reason to believe that through increased efficiency of reclaiming wastes or recirculating his water, the culturist can increase profits. (Hargrove-East Central)

### 2430 - A5, B1, D1, E2 100

### ODOR REDUCTION FOR LIQUID MANURE SYSTEMS,

Environmental Hygiene Department, Karolinska Institute, Sweden
T. Lindvall, O. Noren, and L. Thyselius
Transactions of the ASAE, Vol. 17, No. 3, p. 508-512, May-June, 1974. 4 fig, 5 tab.

Descriptors: Odor, Measurement, Liquid wastes, Injection, Waste disposal, Sampling, Equipment, Cattle, Waste treatment.
Identifiers: Land spreading, Odor reduction, Swine.

In this investigation, different treatment and spreading methods of liquid manure have been compared from the odor point of view. The analyses were carried out with sensory methods under half-scale field conditions. A mobile odor laboratory with sampling equipment carried out parcel experiments on various types of ground (fallow, grassland, and stubble) treated with animal wastes, during different seasons (spring and autumn) and with general tillage implements and spreading equipment. The odor threshold values are expressed as the log dilution factor necessary to attain odorlessness. It was concluded that burial of manure results in a substantial reduction of the odor emission in connection with spreading. Burial is the method which at present can be recommended for this purpose. In areas close to dwellings, injection of manure into the soil can be valuable. By this means, odor emmission, as well as nutrition loss to air and water, are reduced. Of the different methods for manure treatment investigated, the addition of ammonium persulphate to swine manure showed a good effect. (Cartmell-East Central)

### 2431 - B1, C2, C3 100

### NUTRITIVE PROPERTIES OF BROILER EXCRETA AS INFLUENCED BY ENVIRONMENTAL TEMPERATURE, COLLECTION INTERVAL, AGE OF BROILERS AND DIET,

U. S. Department of Agriculture, Agricultural Research Service, South Central Poultry Research Laboratory, State College, Mississippi 39762
L. F. Kubena, F. N. Reece, and J. D. May
Poultry Science, Vol. 52, No. 5, p. 1700-1703, September, 1973. 4 tab, 9 ref.

Descriptors: Nutrients, Temperature, Age, Diets, Amino acids, Proteins, Moisture content.
Identifiers: Broilers, Excreta, Collection interval, Lysine, Methionine.

The purpose of this research was to identify the influence of environmental temperature, collection interval, dietary amino acid levels, and age of broilers on excreta composition. In one trial, diets were calculated to contain 80, 100, or 120 per cent of the recommendations for lysine and methionine plus cystine. Three diets were fed to 5-week-old broilers maintained in 3 chambers having temperatures of 21.2 degrees, 21.1 degrees and 32.2 degrees C. These broilers were kept here for a 5-8 week experimental period. In the second trial, broiler chicks were fed a diet containing approximately 21.7 per cent protein and a metabolizable energy value of 3285 kilo-calories per kilogram. The results of trial 1 show that the total protein equivalent in the excreta increased with the age of the birds. The moisture content of the excreta decreased as the birds increased in age. Total protein equivalent, total amino acids, and ether extract increased with increasing dietary amino acid levels. There was a more dramatic increase in total protein and total amino acid in the excreta from the birds given the diet containing 120 per cent of the recommendation for lysine and methionine plus cystine when compared to the excreta for the birds given 100 per cent of the recommendations. The results of trial 2 show no consistent differences for individual amino acids, total amino acids, total protein equivalent, or ash that was due to environmental temperature or to collection interval. (Cartmell-East Central)

### 2432 - A1, B1, D1, E1, F1, F2 200

### LIVESTOCK WASTE MANAGEMENT CONFERENCE,

Illinois University
Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, 118 p. 32 fig.

Descriptors: Livestock, Illinois, Legal aspects, Feedlots, Design, Waste storage, Solid wastes, Liquid wastes, Lagoons, Research and development.
Identifiers: Waste management, Flushing, Mechanical aerators, Holding ponds, Mosquito control, Land disposal, Pumping, Application rates.

The main objective of the conference was to discuss the planning and design requirements for components of livestock waste management systems, particularly in Illinois. The status of Illinois livestock waste management regulation was discussed in relation to federal regulations. Storage structures for solid and liquid manure systems were examined. In relation to liquid manure disposal, recommendations on the selection of pumps, piping, sprinklers and nozzles were provided. Another aspect of manure-handling was the use of hydraulic flushing to dislodge and transport livestock manure from the deposit point to the place of disposal. Various mechanical aerators were examined as to whether they were preferable to rotors for use in oxidation ditches. The oxygenation and flow characteristics of the aerators were also discussed. The design and construction criteria of holding ponds and lagoons were considered. Another report considered the problem of mosquito control in disposal lagoons. Several factors that determine the application rates of livestock wastes to land were examined. Several projects dealing with animal waste management with pollution control were briefly presented in the Annual Report of Cooperative

Regional Project. Waste-handling systems for three food production units were briefly presented. The units involved were a hog production unit, a beef production unit, and a dairy production unit. (Penrod-East Central)

**2433 - A1, B1, F2 200**

## STATUS OF THE ILLINOIS LIVESTOCK WASTE MANAGEMENT REGULATIONS,

Agricultural Specialist, Division of Water Pollution Control, Illinois Environmental Protection Agency, Springfield
J. F. Frank
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. A1-A5.

Descriptors: Illinois, Legal aspects, Feedlots, Permits, Design.
Identifiers: Waste management, Regulations, Sanitary Water Board, Environmental Protection Agency.

In its later years of existence, the Illinois Sanitary Water Board (SWB) conceived the need for a set of livestock waste management regulations. On July 1, 1970, the SWB's activities were taken over by the Illinois Environmental Protection Agency (EPA). This agency continued the formulation of the livestock waste management regulations. The hearing process and the Illinois EPA's role and position are discussed. Federal regulations are then examined. The U.S. EPA published on December 5, 1972, a proposed set of regulations which covered some agricultural operations. Agricultural interests gave extensive response and a task force was set up to evaluate the responses and, if necessary, redraft and clarify the proposal. A new proposal was drafted during a two-day meeting of this task force which was held on January 29, 1973. After several public meetings with environmental groups, the proposed regulations were published in the Federal Register and a 30-day comment period was set. The operators of the various classes and sizes of feedlots or livestock shelters (as listed in a table) must apply for permits, although they do not necessarily need them. Future plans of the Illinois EPA are discussed. (Penrod-East Central)

**2434 - A2, A4, B1 200**

## STORAGE STRUCTURES FOR SOLID MANURE,

Department of Agricultural Engineering, Wisconsin University, Madison
J. C. Converse and C. O. Cramer
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. B1-B12. 8 fig, 1 tab, 9 ref.

Descriptors: Waste storage, Solid wastes, Separation Techniques, Design criteria, Agricultural runoff, Liquid wastes, Seepage, Nutrients.
Identifiers: Stacking.

Manure stacking in the winter is not a recent development in dairy operations. Interest is increasing in stacking manure for freestall housing where very little bedding is used, although manure stacking is best adapted for stanchion-type housing with bedding systems. Runoff from manure stacks located near streams can cause stream pollution, so care must be taken in choosing a site for the stack. Manure-handling systems also have to be designed to maintain good farmstead sanitation, particularly with dairy operations. Summertime stacking may put a greater demand on farmstead sanitation. The objective of this report is to review the storage of solid manure, discussing the various types of structures, management and problems in using the system. Research is currently underway to design optimum storage facilities that will minimize pollution, that will be economical, and that will not distract from the aesthetics of the farmstead. The manure storage system can be a good management tool, if properly designed. Storage structure size is dependent on the number of days of storage, the number and size of the animals, the type of manure handling needed, and the type and amount of bedding used. Other conclusions and recommendations cover bunker-type storage, seepage from a stack, and the emptying of detention ponds. (Penrod-East Central)

**2435 - B2 200**

## MANURE STORAGE TANKS FOR LIQUIDS,

J. O. Curtis
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. C1-C8. 2 fig, 2 tab, 3 ref.

Descriptors: Waste storage, Liquid wastes, Design.
Identifiers: Manure storage tank.

In recent years, a fairly large number of manure storage tanks for liquids have been constructed on farms with many more anticipated to be constructed in the future. Most of these tanks are located either outside the livestock building but nearby or under the floor of the building. The objective of this report is to discuss the available basic information that is related to tank design, illustrate its use, point out reasons for recommended variations, and to review some aspects of the Midwest Plan Service (MWPS) tank design. Available basic design information is given with respect to design loads, and the designing of manure storage tanks to resist loads. The report concludes that MWPS Plan 74303 is probably the best generally available plan for liquid manure tanks. It is a fairly conservative design with respect to the amounts of temperature and shrinkage, steel required, and the soil pressures assumed. In the future, the promotion of less conservative designs than the MWPS Plan may more safely be undertaken as more experience is gained with manure tanks and as more follow-up information is obtained on any tank failures. (Penrod-East Central)

**2436 - B2, D4, E2, E3 200**

## MANURE-HANDLING BY HYDRAULIC FLUSHING

Department of Agricultural Engineering, Iowa State University, Ames
T. E. Hazen
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. D1-D11. 3 fig.

Descriptors: Design, Liquid wastes, Recycling, Confinement pens, Waste storage, Waste treatment, Pumping.
Identifiers: Hydraulic flushing, Dosing syphon, Tipping basket, Land disposal.

This report describes the design and application of systems that use a flowing liquid to dislodge and transport livestock manure from the point of deposit to the place of disposal. Enclosed confinement makes hydraulic collection and transport of manure a feasible method. There is some means for manure collection, transport, treatment, storage and disposal in any waste-handling system. In hydraulic flushing, it should be recognized that this method magnifies by 10 to 100 the amount of material put into motion. That a uniform flow is established along the entire length of the channel is assured by the flushing duration being long enough. There are several flushing devices. Among them is the dosing syphon which is a highly reliable and almost maintenance free means of rapidly discharging large volumes of stored liquid at a controlled rate and for a desired duration. Recycling requires no extra storage in a system other than to assure that the needed quantity and quality of liquid for the flushing devices is always available. Aerobically stabilized liquids can be handled by most of the conventional commonly available pumps, if properly screened. Some liquid will need to be removed periodically from any manure-handling system unless evaporation, seepage, or other losses are unusually high. Three major concerns still exist in the recycling system: (1) Ingestion and flushing liquid by livestock could aggravate transmission and prolongation of disease, (2) potential odor production, and (3) Repair or replacement of a return pump. (Penrod-East Central)

**2437 - B2, D4 200**

## OXYGENATION AND FLOW CHARACTERISTICS OF MECHANICAL AERATORS,

Department of Agricultural Engineering, Illinois University, Urbana-Champaign
J. K. Mitchell and D. L. Day
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. E1-E13. 7 fig, 1 tab, 9 ref.

Descriptors: Aeration, Oxygenation, Equipment, Flow characteristics.
Identifiers: Oxidation ditch, Mechanical aerators.

Increased interest in aerobically treating livestock wastes has led to a proliferation of aerobic methods and devices. Studies were conducted at the University of Illinois with two main objectives: (1) to determine the relative efficiency of three types of aerators with respect to oxygenation and liquid flow, and (2) to determine if some modification could be made to eliminate the areas of solids deposition by studying flow patterns in an oxidation ditch. The report data showed that some type of standardization by manufacturers and researchers in reporting the oxygenation and flow efficiency of various aerators is needed. The most useful index for comparing oxygenation effeciencies between aerators is the common parameter of oxygenation rate in pounds of oxygen per kilowatt hour. A flow/power parameter, in c.f.s/kw., may be a useful index if the liquid flow velocity is of concern for a particular oxidation ditch design. That the areas of low velocity, and hence, areas of potential settlement can be reduced with some form of center-wall and end section modification was shown by the flow pattern study. Before choosing a particular aerator device for a particular system, the different installation, maintenance, and operation advantages and disadvantages of each device should be considered. (Penrod-East Central)

**2438 - A5, B2, D1, E1 200**

## DESIGN AND CONSTRUCTION OF HOLDING PONDS AND LAGOONS,

Soil Conservation Service, Champaign, Illinois
P. Christensen
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. F1-F9. 1 tab.

Descriptors: Waste disposal, Lagoons, Agricultural runoff, Design criteria, Settling basins.
Identifiers: Holding ponds.

Waste management facilities must be designed, planned, and constructed to permit the operator to efficiently manage waste production and effectively minimize potential pollution hazards. The major components of waste management systems are manure storage structures, holding ponds, and disposal lagoons. This report discusses the design and construction of holding ponds and disposal lagoons. A holding pond is an impoundment for the collection and temporary storage of contaminated runoff from areas having concentrated animal waste. These ponds should be located as near the source as feasible, giving due consideration to odor and wind patterns. They should be located on watertight soils or on soils that seal easily. Settling basins are installed between the feedlot and holding pond to minimize frequent hauling of solids from holding ponds, to lengthen their life and to facilitate removal of stored contaminated runoff. The mean velocities of channels used for settling basins should be approximately 1 foot per second to permit settling of solids. The design and management of holding ponds are discussed. Disposal lagoons are defined as being impoundments made by constructing embankments or excavating areas to create a reservoir for biological stabilization and storage of organic waste. Lagoon design must consider all state and local regulations. Lagoon sight conditions are discussed. For design purposes, lagoons are commonly grouped according to their predominant biological characteristics: anaerobic, aerobic, or facultative. Each type of lagoon is examined individually. Lagoon design, operation and maintenance is discussed. Recommendations for holding pond and lagoon operation and maintenance are listed. (Penrod-East Central)

**2439 - A8, D2, D3 200**

### MOSQUITO CONTROL IN LIVESTOCK WASTE LAGOONS IN ILLINOIS, 1972,

Professor of Agricultural Entomology and Entomologist, Illinois Natural History Survey; Research Assistant, Illinois Natural History Survey
S. Moore III and J. Tranquilli
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. G1-G3. 1 tab.

Descriptors: Lagoons, Mosquitoes, Larvicides, Vectors.
Identifiers: Chemical control, Vegetation removal.

During recent years heavy populations of the northern house mosquito, Culex pipiens pipiens, have been observed breeding in livestock waste lagoons. This insect's presence is of great concern as it is a vector of the virus causing human encephalitis. This study's objective was the devising of effective and yet practical methods of control of the vector in animal waste lagoons. Both chemical and cultural controls were utilized. For the study, seven livestock waste lagoons on the animal science research farms at Urbana-Champaign were used. A heavy growth of marginal vegetation conducive to mosquito breeding was around each of the lagoons. Two lagoons (OSF and MA) were selected for the cultural control method, involving the removal of the marginal vegetation and floating debris. Three of the lagoons were selected for the chemical treatment method of control of mosquito larvae. The remaining two lagoons (Physiology and MD) were left untreated as controls. The study showed that the cultural control method reduced house mosquito larval populations to near zero. Until the marginal vegetation became flooded, significant mosquito larval populations did not appear in the untreated MD lagoon. An increase in larval populations was noted for OSF and MA when a regrowth of vegetation occurred. Flit MLO treatments and Malathion both effectively suppressed mosquito larval populations for about one week. Recommendations for lagoon design, vegetation removal, and chemical treatments for suppressing mosquito larval populations are listed. (Penrod-East Central)

**2440 - A1, B1, D1, E1 200**

### REVIEW OF LIVESTOCK WASTE RESEARCH AT THE UNIVERSITY OF ILLINOIS--ANNUAL REPORT OF COOPERATIVE REGIONAL PROJECT,

Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. H1-H11.

Descriptors: Research and development, Livestock, Swine, Proteins, Feedlots, Cattle, Rain, Anaerobic conditions, Aerobic conditions, Equipment, Sheep, Nitrogen, Fish, Mosquitoes, Gases, Dusts.
Identifiers: Illinois University, Waste management, Pollution control, Refeeding, Erodibility, factor, Odor control, Municipal digester sludge, Oxidation ditch.

All of the projects reviewed concern animal waste management with pollution control. The various projects are described briefly and the progress of work and principal accomplishments of each are discussed. The projects are: (1) Refeeding of aerobically-processed swine waste, (2) Optimum rate of harvesting protein from aerobically processed swine wastes, (3) Erodibility factor for beef cattle feedlots exposed to rain, (4) Odor control and degradation of swine manure under anaerobic conditions by adding municipal digester sludge, and (5) Testing of aeration equipment for livestock oxidation ditches. Related research projects include: (1) The nutritive value of sheep feces. (2) Nitrogen as an environmental quality factor, (3) Fish culture and mosquito control in livestock waste ponds, and (4) Effect of gases and dust on swine. Work planned for the following year of 1973 is listed. (Penrod-East Central)

**2441 - A1, B2, E2 200**

### SELECTION OF PUMPS, PIPING AND WASTE DISTRIBUTION EQUIPMENT FOR LIQUID MANURE DISPOSAL,

President, Sprinkler Irrigation Corporation, East Peoria, Illinois
R. Schneider
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. 11-112. 3 fig.

Descriptors: Equipment, Liquid wastes, Waste disposal, Pumps, Pipes, Clogging, Irrigation, Erosion, Compaction, Temperature.
Identifiers: Selection criteria, Nozzles, Sprinklers, Gated pipe.

Pumping of animal waste on open land is fairly new in the United States, although this method of animal waste disposal has been used for many parts of the world. The objective of this report is to discuss the selection of pumps, piping, and waste distribution equipment for liquid manure disposal. Two primary types of pumps are described. The first type, low head, is designed to move a mixture of liquids and solids from the sump pit to the settling basin. The kinds, sizes and selection of this type of pump are discussed. The second type of pump, the high head, moves large volumes of liquid over long distances at high pressures. The two primary considerations in pipe size selection are: (1) the amount of liquid to be pumped, and (2) the horizontal distance the liquid must be pumped. The understanding of nozzle size and nozzle pressure relationship is important in order to properly select sprinklers and nozzles for effluent distribution. The primary limitations on nozzle size selection are compaction, erosion, crop damage, and wash. The pros and cons of gated pipe are discussed. If pumping is done in freezing temperatures, the main objective is to keep the water moving to avoid freezing of the effluent. The report concludes with a comparison of hauling and pumping as far as adaptability to different needs. (Penrod-East Central)

**2442 - A1, A3, A4, E2 200**

### DETERMINING APPLICATION RATES OF LIVESTOCK WASTES TO THE LAND,

Soil Fertility Extension, Illinois University, Urbana-Champaign.
S. R. Aldrich
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. J1-J12. 1 fig, 1 tab, 26 ref.

Descriptors: Farm wastes, Livestock, Poultry, Nitrates, Water pollution, Groundwater pollution, Phosphorus. Salts, Ammonia, Denitrification, Agricultural runoff.
Identifiers: Land disposal, Application rates, Yields.

Much trial and error has occurred in trying to determine the application rates of livestock wastes to the land. The objective of this report is to examine the disposal on agricultural land of collected animal wastes. The study showed that the safest program for manure disposal consists of 10-20 tons of large-animal waste or 5-10 tons of poultry waste per acre per year applied for the purpose of efficient utilization by responsive crops. In the immediate future, the permissable manure loading on agricultural land will be determined by the amount of nitrogen. Between 150 and 250 pounds is the amount of nitrogen that can be introduced into the soil annually without substantial buildup in $NO_3$. Poorly drained, fine-textured soils are sites that maximize denitrification and will tolerate heavier rates than well-drained, coarse-textured soils. The permissible rate of manure may be increased if the receiving water is low in nitrate and is large in volume relative to the water from the manured area. Where the water is discharged to a lake or reservoir directly or via a stream, the amount of phosphorus in drainage water may be the limiting factor in waste application. Ammonia concentration or salt concentration or both may limit the amount of manure that can be applied at one time without injuring germination and plant growth. On sloping land where runoff into surface waters is likely with normal rainfall, large surface applications are not acceptable. Future designing of large livestock operations must include proper waste disposal in the planning. (Penrod-East Central)

**2443 - B1, E2, 200**

### OUR WASTE-HANDLING SYSTEM FOR HOGS,

Gehlbach Pork Farms, Inc., Lincoln, Illinois
G. D. Gehlbach
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. K1-K2.

Descriptors: Lagoons.
Identifiers: Swine, Land application, Slotted floors, Application rates.

Gerald Gehlbach traces the waste handling measures utilized on Gehlbach Pork Farms from 1961 to the present time. At present, Gehlbach farms produces over 8,000 hogs annually in a farrow-to-finish production-line type of operation. All market production is housed in environmentally controlled, totally slotted floor buildings with liquid manure pits below the slats. For waste disposal, a 7.5 acre waste lagoon is used in combination with hauling to cropland and injection into the soil. Acreage utilized for corn production has increased over the years as amount of animal wastes for disposal have increased. In the fall of the year every attempt is made to pump empty all of the pits below the slats and field-apply the manure prior to the fall plowing of corn fields. The normal application rate at this time is 20-25 tons of liquid manure per acre. Hauling is resumed in the spring when applications can be made on the remaining unplowed fields. During the summer the manure is again knifed into the soil on the cropland set aside from corn production in the Feed Grains Program. Because of acreage limitations, the application rates are usually higher here. The 7.5 acre lagoon is utilized for collection of the wastes during the winter when manure cannot be injected into the soil and during rainy times during the summer. The lagoon also receives some of the more liquid portion of the waste to reduce the volume that needs to be hauled to cropland. Mr. Gehlbach feels that this waste handling program is the most economical and acceptable method of disposal today. (Merryman-East Central)

**2444 - A2, B2, E2 200**

### MY WASTE-HANDLING SYSTEM FOR BEEF,

Beef producer, Elgin, Illinois
K. H. Bartels
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. L1.

Descriptors: Agricultural runoff, Water pollution, Feedlots, Cost sharing.
Identifiers: Holding pond.

The report discussed the correction of a feedlot wastes runoff problem. Runoff was going directly into a drainage ditch approximately 100 feet from the feedlot. With the aid of the Soil Conservation Service a waste control plan was devised. The only equipment changed for the waste handling procedure was a pump and irrigation equipment for dispensing water from the holding pond. The approximate completion cost of the project will be about $3,200 (excluding pump and equipment), but cost-sharing was utilized. The runoff now no longer pollutes the creek and the area below the feedlot is much cleaner. (Penrod-East Central)

### 2445 - A1, B2, E3, 200

## MY WASTE-HANDLING SYSTEM FOR DAIRY,

Dairy producer, Paris, Illinois
H. Boland
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, p. M1-M2.

Descriptors: Waste storage, Waste disposal, Liquid wastes, Dairy industry, Design, Costs, Cost sharing.

Due to a road building program along his property line, in 1971 Mr. Boland changed his waste handling practices to a liquid manure system. Extensive changes were required. A 105,000 gallon storage tank for the milking barn was installed beneath a 24' x 30' slatted floor and a 24' x 40' solid floor with three drag holes. A 1,000-gallon septic tank servicing the milk house and milking parlor was connected to a drain line to the storage tank and a manure pump was installed to automatically pump waste water into the storage tank. The storage tank is emptied by using a PTO-operated manure pump and a 1,500-gallon liquid spreader. The wastes are spread on fields that are not rolling or close to an open stream. The spreading area is approximately one-fourth mile from any residence. Help from the SCS, the Cooperative Extension Service, the University of Illinois, and the ASC office was acknowledged. Aid was received under the REAP Program. Cost was briefly discussed. (Penrod-East Central)

### 2446 - A1, B1, E1 200

## LIVESTOCK WASTE MANAGEMENT IN A QUALITY ENVIRONMENT,

Extension Agricultural Engineer, Cooperative Extension Service, Illinois University, Urbana-Champaign
D. G. Jedele, Editor
Presented at Proceedings of 1973 Livestock Waste Management Conference, Champaign, Illinois, March 7-8, 1973, Circular 1074, p. 1-15. 8 fig, 1 tab.

Descriptors: Feedlots, Livestock, Agricultural runoff, Liquid wastes, Lagoons, Confinement pens, Solid wastes.
Identifiers: Waste management, Hauling, Gutter flushing, Oxidation ditch, Odor control, Dead animal disposal.

This circular was prepared to assist the livestock producer in assessing the pollution potential of livestock operations and to provide a systematic approach to resolving problems. The circular does not incorporate extensive technical data on buildings, manure collection and handling facilities, or equipment. It does delineate the parts of a waste management system, listing alternatives that may be used. Systems for reducing *water pollution are described including: (1) Feedlot* runoff control for unrestricted space, (2) Feedlot runoff control for restricted space, (3) Liquid manure system—hauling, (4) Liquid manure system—lagooning, (5) Liquid manure system—hauling and lagooning, (6) Gutter flushing in a confinement building, (7) Oxidation ditch in a confinement building and (8) Solid and liquid system for dairy facilities. Suggestions are given for reducing odor. Options for dead animal disposal are discussed. (Merryman-East Central)

### 2447 - A2, A4, B1 100

## SOIL WATER NITRATE BENEATH A BROAD-BASIN TERRACED FEEDLOTS,

U. S. Department of Agriculture, Nebraska University, Lincoln
L. F. Elliott, T. M. McCalla, N. P. Swanson, L. N. Mielke, T. A. Travis
Transactions of the ASAE, Vol. 16, No. 2, p. 285-286, 293, March-April, 1973. 10 ref.

Descriptors: Soil water, Nitrates, Feedlots, Agricultural runoff, Nebraska, Denitrification.
Identifiers: Broad-basin terraced feedlot.

Nitrate accumulations occur beneath some feedlots but not others. Some recent studies indicate the possible role of management in nitrate accumulation beneath feedlots. More recent reports indicate continuous stocking of feedlots may preclude nitrate accumulations beneath them. Further investigation is warranted as runoff-control systems may complicate the situation. Swanson (1973) described a broad-basin terrace system that meets Nebraska runoff-regulatory requirements. The objective of this study was to determine if excessive nitrate accumulations in the feedlot soil profile would be caused by this system. Initiated in an 8-month-old, broad-basin terraced feedlot, caisson studies showed that soil water nitrate values rose initially. When the study was terminated, after 13 months, $NO_3$-N at 2, 4, and 5 ft. was 1.4, 10, and 12.5 ppm, respectively. Oxygen decreased and $CO_2$ increased during the latter part of the test period, indicating reducing conditions were occurring. The establishment of reducing conditions and the decrease in nitrate are indications of denitrification. Test results indicated that nitrate did not percolate below 5 ft. (Penrod-East Central)

### 2448 - A1, D4, E2 700

## TRANSFORMATION, MOVEMENT, AND DISPOSAL OF NITROGEN FROM ANIMAL MANURE WASTES APPLIED TO SOILS,

B. L. Carlile
Unpublished Ph.D. Dissertation, Washington State University, Pullman, 1972, 70 p. 7 fig, 14 tab, 50 ref..

Descriptors: Nitrogen, Slurries, denitrification, Temperature, Carbon.
Identifiers: Land application, Anaerobic filters.

The objectives of this investigation were: (1) the determination of the transformation, movement, and disposal of nitrogen from animal manure wastes applied as a slurry at various rates to soils; and (2) the evaluation of the effectiveness of anaerobic filters for denitrification of nitrate-rich water. Soils receiving lower rates of manure applications had a greater initial rate of nitrification than did those receiving the highest rates, probably because of the ammonium inhibition of nitrifiers at higher manure application rates. Unless some measures for removing nitrates from the drainage water were implemented, all manure treatments resulted in nitrate concentrations sufficiently high to become a potential pollution hazard. The anaerobic filter may be practical for "on farm" treatment of soil drainage waters as it was shown to be effective for removing nitrate from nitrate-rich *waters through the denitrification process. Using* methanol as the source of carbon, nitrogen removal efficiencies of over 90 per cent were achieved at hydraulic detention times of under one hour in the treatment filter. In order to achieve satisfactory nitrogen removal, a readily biodegradable source of carbon must be added along with the soluble manure components. Milk was found to be such a source. With a reduction in temperature, no clear pattern of changes in nitrate removal efficiencies was observed, but when milk was utilized as the sole energy source, nitrate removal efficiency appeared to have been increased at lower temperatures. (Penrod-East Central)

### 2449 - B2, D2, F1 100

## ENHANCED TREATMENT OF LIVESTOCK WASTEWATER. I. SOLID-LIQUID SEPARATION--ESTIMATION OF VIBRATORY SCREEN PERFORMANCES ON SWINE WASTEWATER,

Agricultural Pollution Control Laboratory, Department of Agricultural Engineering, Michigan State University, East Lansing 48823
P. O. Ngoddy, J. P. Harper, and J. B. Gerrish
Journal of Agricultural Engineering Research, Vol. 19, p. 313-326, 1974.

Descriptors: Waste water treatment, Separation techniques, Livestock, Dimensional analysis, Costs, Screens.
Identifiers: Swine.

The number of experimental studies on performance evaluation of a variety of sludge de-watering devices for solid-liquid separation of livestock wastes is increasing. The promise of minimizing capital investment costs on livestock wastewater management systems by substantially reducing the total bulk of water polluted and subsequently stored and-or processed is offered by the recycling of reclaimed wastewater. This study examines the vibrating screen separator for solid-liquid separation of livestock wastewater. Dimensional analysis is used as a rational basis for quantitatively evaluating the vibratory screen performance. Tests were run on swine waste-water and on one type of vibrating screen machine—the kind which derives its basic vibrational motion from the interaction of suspension drive springs and rotating weights driven at known angular velocity. Graphs of optimization plots (swine wastewater) and performance curves for swine wastewater are given. Tables are provided on the variables affecting the performance of vibrating screen separator, on sieve analysis and the removal percentage estimates of swine wastewater solids and on the results of vibrating screen separator test on swine wastewater. (Kehl-East Central)

### 2450 - A1, B1, D1, E3 100

## ANAEROBIC DIGESTION OF HOG WASTES

Iowa State University, Ames, Iowa
E. P. Taiganides, E. R. Bauman, H. P. Johnson, and T. E. Hazen
Journal of Agricultural Engineering Research, Vol. 8, No. 4, p. 327-333, 1963. 5 fig, 9 ref.

Descriptors: Anaerobic digestion, Design, Hogs, Temperature, Methane, Nitrogen, Costs.
Identifiers: Liquefaction, Gasification.

The anaerobic sludge digestion process was evaluated and the results of a laboratory study on the application of sludge digestion for the treatment of swine wastes was reported. Several advantages and limitations of the digester process were discussed. The process can be carried out within a wide range of temperatures, provided that the temperature is maintained at a constant level. The rate of digestion increases with temperature from 32 to 104 degrees F, though the nature of the process changes and evolu*tion of methane is much less at the lower and upper* limit of the range. Two phases of decomposition occur in the digestion of organic matter: the liquefaction stage and the gasification stage. Results revealed that the fertilizer value of manure as measured by the nitrogen content was increased through digestion. The organic matter of the raw manure and, thus, its potential pollutional strength was reduced by 60-70 per cent through digestion. Considerations for the design of a digester were discussed. Although the initial investment for a digester is high, profit may be realized by operations producing over 10,000 hogs per year through the utilization of the excess combustible gas produced during digestion of the wastes. (Cameron-East Central)

## 2451 - A1, B1, E1 300
## LIVESTOCK FEEDLOTS ARE POLLUTION SOURCE,

Health Officer, Lyon County, Minnesota
P. Bosley
Medical Bulletin of the University of Minnesota, p. 3-6, March-April, 1971. 2 fig.

Descriptors: Feedlots, Water pollution, Minnesota, Biochemical oxygen demand, Nitrates, Sewage, Coliforms.

The discharge of animal and human waste into Minnesota lakes and rivers is a serious pollution hazard. Many farmers have dug a direct connection to rivers, streams, and lakes, piled excess manure on the edge of lakes, allowed their animals to defecate on frozen lakes, and left dead animals on riverbanks and in lakes. Several reports indicate that those practices are health hazards. Lake Yankton is used as a cesspool for the community of Balaton. County ditches, which collect wastes and run into rivers, are ubiquitous. County Ditch 29 had a massive B Coli count, and a toxic nitrate level of 17 at its start. The Minnesota Pollution Control Agency (PCA) is taking no action on this, and has forgotten the January, 1971, deadline imposed on the community of Ruthton to submit detailed plans for a sewage treatment system. The Redwood River (before the community of Marshall with a population of 10,000 empties its untreated sewage into it) has a B Coli count of 110,000 per 100 ml, while the accepted norm is 1,000 per ml. The BOD is over 30. Enforcement of regulations must be stricter, farmers must improve their feedlots, and sewage treatment facilities must be built. (Solid Waste Information Retrieval System)

## 2452 - A9, A10, E3 300
## RECYCLING ANIMAL WASTES,

Department of Animal Science, Iowa State University
K. C. Moellers and R. L. Vetter
The Iowa State University Veterinarian, Vol. 36, No. 3, p.88-90,92-94 1974.

Descriptors: Recycling, Farm wastes, Poultry, Cattle, Feeds, Nitrogen, Phosphorus, Potassium.
Identifiers: Swine, Composition.

The field of recycling animal wastes has become alive in the last five years. The main advantage of recycling would be the potential conservation of nitrogen, phosphorus, and essential mineral elements. Recycled wastes would be of limited value as an energy source; however, they may be of some value in a situation of roughage replacement. Dehydrated poultry waste can be used in rations for laying hens at levels up to 25 per cent of the total diet without decreasing egg production. There are many different processing methods being developed to improve cattle wastes as a feed. It has been demonstrated that cattle will readily consume processed manure up to 40 per cent of a basal ration. Dried swine feces have been added to swine diets up to 15 per cent while sustaining performance. Among present disadvantages in refeeding of wastes are the following: (1) inability to make content of wastes consistent, (2) need for research concerning disease transmission through refeeding of wastes, (3) need for more research concerning toxicological and drug residue problems associated with refeeding, and (4) aesthetics. It is hoped that with further research and experience, recycling of wastes will prove to be of economic value. (Cameron-East Central)

## 2453 - A1, B1 200
## AGRICULTURAL WASTES IN ARID ZONES,

Department of Civil Engineering, New Mexico State University, University Park
J. W. Hernandez
Health Related Problems in Arid Lands, American Association for the Advancement of Science Committee on Desert and Arid Zone Research Symposium, Arizona State University, Tempe, April 21-24, 1971, p. 37-43. 1 tab, 8 ref.

Descriptors: Farm wastes, Domestic wastes, Water pollution sources, Water quality, Consumptive use, Economic efficiency, Environmental effects, Waste water (Pollution), Ethics, Agriculture, Drainage water, Irrigation water, Arid lands, Return flow, Feedlots, Cattle, Poisons, Economics, Political aspects, Social aspects, Irrigation practices, Pesticides.

Three current agricultural waste disposal problems are common to much of the arid and semiarid regions of the United States, namely, return flows from irrigation, cattle feed-lot wastes and economic poisons. Characteristics of each are given and discussed. Regulation of existing irrigation projects by the imposition of water quality standards is unlikely in arid regions. As long as the attitude prevails that unused water is wasted and that it is in the national interest to make arid lands productive through irrigation, there will be continued pressure to import additional water supplies for arid-land irrigation. (Black-Arizona)

## 2454 - D1, E3 400
## WHY WASTE ANIMAL WASTES?

American Beef Producer, November, 1971, p. 10-11. 1 fig.

Descriptors: Waste disposal, Recycling, Lagoons.
Idenifiers: Animal wastes, Ecolite, Aerobic digestion, Oxidation ditch, Composting, Building materials

Disposing of animal waste is a problem which is being tackled anew each day by agricultural scientists John D. Mackenzie, University of California, developed Ecolite, a combination of treated cow dung (made by putting feedlot manure through a high temperature kiln) and melted glass. In addition to being lightweight, Ecolite is versatile and can be made into blocks, boards, panels, tiles or shingles. It can even be used as an air or water filter. In Iowa, cow dung is being recycled and refed to steers. Effluent is circulated beneath slotted floors in an oxidation ditch. Oxygen and water are added for "aerobic digestion", or breakdown. Tests indicate there are no DES or antibotic residues. Test animals averaged 3.42 pounds gain per day while the control steers gained 3.36 pounds. Cost of gain was 22 cents a pound. Lagoons where wastes are dumped to allow aerobic decomposition provide another method of disposal. Composting reduces raw organic material to a loose workable, odorless nutritive soil additive. (Cameron-East Central)

## 2455 - A4, E2 700
## CHEMICAL CHARACTERISTICS OF SOIL PERCOLATES FROM LYSIMETERS TREATED WITH MANURE,

D. G. S. Bielby
M. S. Thesis, University of Guelph, 1970, 123 p. 5 fig, 16 tab.

Descriptors: Chemical properties, Percolation, Lysimeters, Nutrients, Soil profiles, Nitrogen, Phosphorus, Potassium.
Identifiers: Groundwater pollution, Corn.

An attempt was made to establish the qualitative and quantitative contributions of different rates of manure to ground water contamination. A lysimeter study was conducted from February, 1968 to September, 1969. Specific objectives were: (1) To evaluate the lysimeters used in this study of nutrient percolation through a natural soil profile. (2) To determine the effects of high rates of liquid manure on a Guelph loam growing corn as a cover crop. (3) To determine the effects on groundwater quality of different rates of manure applied to a Guelph loam. (4) To account for the nitrogen applied in the manure. The following conclusions were drawn: (1) The natural soil profile lysimeters were adequate for obtaining leachate samples. On a seasonal basis, there was no difference in the volume of percolates between treatments. (2) The experimental design was not adequate to detect significant treatment differences when total nitrogen was measured. (3) Before fall data was included, 81.8 to 87.8 per cent of the added nitrogen could not be accounted for. When the October and November, 1969, data was added, the per cent of the added nitrogen not recovered was 38.3 to 61.5. (4) At least 20 per cent of the added nitrogen was in nitrate form and was leached out of the lysimeters by the flushing treatment. (5) Although corn has a high nutrient requirement, the period during which the plant takes up nutrients doesn't coincide with nitrogen movement downward and into the groundwater. Either some other crop should be grown to intercept the nitrogen moving into the groundwater during the spring and fall; or, the manure should be applied nearer to the time of maximum uptake by the corn. (6) Addition of manurial phosphorus and manurial potassium to the soil had very little effect on levels in the soil percolates. (Merryman-East Central)

## 2456 - A8, B1 100
## WINTER INOCULATIVE RELEASES OF PARASITOIDS TO REDUCE HOUSEFLIES IN POULTRY MANURE,

Division of Biological Control, Department of Entomology, California University, Riverside 92502
G. S. Olton and E. F. Legner
Journal of Economic Entomology, Vol. 68, No. 1, p. 35-38, February 17, 1975. 4 tab, 6 ref.

Descriptors: Vectors, Winter, Pest control, Temperature.
Identifiers: Poultry, Parasitoids, Houseflies.

The objective of this study was to determine the effectiveness of parasitoids on the reduction of houseflies in poultry manure. A poultry ranch was selected in the interior area of southern California for periodic inoculative releases of fly parasitoids to evaluate their colonization and relative activity on winter fly populations. The study was conducted during the period, December-April, 1969-1970. Three parasitoids were used: Tachinaephagus zealandicus Ashmead, Sphalangia endius Walker, and Muscicifurax raptor Girault and Sanders. M. domestica parasitization increased from a low of 3 per cent in January to a high of 46 per cent by mid-April. When host densities were increasing in later March and April, Fannia spp. parasitization increased to 16 per cent. The apparent superiority of T. zealandicus activity during colder weather may be related to the innate preferences of this parasitoid for lower temperatures and to the increases in the developmental time of the hosts, making them available for a longer period of time. These conditions favor both a numerical and functional response of the parasitoids. (Penrod-East Central)

## 2457 - A1, B1, D1, E1 200
## PROCEEDING OF SYMPOSIUM ON THE CONVERSION OF POULTRY

### WASTE TO ENERGY, FEED, OR FERTILIZER,

Pennsylvania State University
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, 32 p. 2 fig, 1 tab, 90 ref.

Descriptors: Poultry, Solid wastes, Energy, Feeds, Fertilizers.
Identifiers: Conversion, Manure.

This symposium is devoted to the exploration of successful methods of converting solid poultry waste into energy, feed or fertilizer. When converted through chemical, physical, biological or aesthetic processes, this by-product can become useful, marketable, or harmless to us or our environment. The most common use of poultry manure is in land spreading and as a fertilizer. (Cameron-East Central)

### 2458 - A5, B3, D2 200

### THE MECHANICS OF AIR DRYING,

Instructor and Assistant Manager, Penn State Poultry Operation.
T. Burr
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, p. 1-3.

Descriptors: Poultry, Moisture content, Costs, Dehydration, Aerobic conditions, Anaerobic conditions, Ventilation, Waste treatment.
Identifiers: Air drying, Agitation, Manure.

Researchers at Penn State are trying to solve the problem of handling poultry waste by utilizing the ventilation in the poultry house and body heat from the birds to dry the manure and then take this product and run it through a commercial dehydrator. In order to prevent anaerobic bacterial action and thus decrease odors, the manure must be dried from its 70-80 per cent moisture level to under 10 per cent moisture. The Sloping Wire Floor System, developed by Penn State for housing birds, lent itself readily to inhouse manure drying. The first step in manure drying was agitation of the manure to keep it in an aerobic state. Penn State built their own manure rakes, using the spike-toothed harrow arrangement as a manure rake. Together with agitation, air movement over the exposed surface of the manure is necessary to remove moisture. House ventilation is also very important for drying poultry manure. Electric heat cables were installed in the concrete floors beneath the manure. This aided in the drying of the manure but the cost was prohibitive. In stage-one drying system, the moisture content is reduced from 75-80 per cent to 25-30 per cent moisture and the cost would be $17.16 per ton. The stage-two drying system reduced moisture content from 25-30 per cent moisture to 10 per cent moisture and it cost $23.11 per ton. (Cameron-East Central)

### 2459 - D4, E3 200

### FERMENTATION AS A FEED PRODUCTION METHOD,

Poultry Science Extension, Pennsylvania State University
O. D. Keene
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, p. 4-8. 14 ref.

Descriptors: Fermentation, Feeds, Recycling, Bacteria, Algae, Yeasts, Proteins, Cellulose.
Identifiers: Feed ingredients, Animal wastes, Hydrocarbons, Single cell protein, Conversion.

Fermentation has potential in producing food for man and animals. Research is now generally geared to study microbial fermentation on industrial wastes which contain organic compounds such as acetic acid, butanols, acetaldehyde, etc. Converting hydrocarbon wastes to single cell protein has been done with yeasts, bacteria and algae. These microorganisms have potential as animal feed ingredients. Ruminants utilize cellulosic wastes by rumen fermentation where microorganisms convert carbohydrates to microbial proteins, fatty acids, $CO_2$ and $CH_4$. Low quality cellulosic wastes have to be changed if they are to be used as feed ingredients. Anaerobic fermentation systems are usually less expensive than aerobic systems because oxygen doesn't have to be pumped into the system. Systems utilizing yeasts, bacteria, or algae all appear to have some promise in converting animal waste into feed ingredients particularly for single stomached animals. (Cameron-East Central)

### 2460 - A1, D2, E3 200

### MARKETING CONVERTED MANURE,

Pennfield Farms Inc., Ephrata, Pennsylvania
G. H. Herr
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, p. 9-12.

Descriptors: Marketing, Fertilizers, Feeds, Costs, California, Iowa, Legal aspects, Nutrients.
Identifiers: Dried poultry waste, Anaphage, Shud, Food and Drug Administration.

The author feels that the prime areas for marketing the finished dried poultry waste product is in the fertilizer and feed industries. The author states that the feeding opportunities have the most potential and that every day's delay of approval in F.D.A. is a crime and a waste of beneficial resource that should be helping us fight the battle of feed price inflation and world wide starvation. All tests of manure as a feed ingredient have been favorable to date. Many different people are testing samples of DPW. From some of the tests conducted in ruminant animals, it would appear that "quality DPW" should carry a value of two-thirds that of soy meal or 70 per cent that of corn. The protein in DPW is about 60 per cent uric acid and it takes a ruminant to convert this to energy and meat. Some tests showed results that veterinary bills were cut 50 per cent in a feedlot situation. Proper dehydration and fair marketing or usage could add conservatively 50-60 cents additional income per layer. There is an opportunity here to help solve two problems—environment and starvation—while the possibility exists to also turn a profit. (Cameron-East Central)

### 2461 - A1, B1, E2, E3 200

### BROILER LITTER FOR CROP PRODUCTION,

Extension Agronomist, Delaware University
W. H. Mitchell
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, p. 13-16. 2 fig, 1 tab, 2 ref.

Descriptors: Poultry, Fertilizers, Costs, Crop production, Delaware.
Identifiers: Broiler litter, Application rates.

Large amounts of poultry litter are available in areas of the Delmarva Peninsula. On the average, the moisture content of the manure will be about 25 per cent but may range from 10-60 per cent. Litter produced in Delaware also contains about 2 per cent nitrogen, phosphorus and potassium and important amounts of micronutrients. Assuming current fertilizer prices, each ton of broiler litter would contain $N\text{-}P_2O_5\text{-}K_2O$ worth $23.20. Current fertilizer economics have stimulated a renewed interest in the product for crop production purposes. The best corn yields are obtained when broiler litter is applied at relatively low rates. Several tests are underway involving possible uses for the solid waste-poultry manure product. These include soil modification utilizing chiseling and the deep placement of broiler litter. (Cameron-East Central)

### 2462 - B1, D1, E3 200

### PRODUCTION OF METHANE FROM POULTRY MANURE,

Poultry Science Extension, Pennsylvania State University
H. C. Jordon
Proceedings of Symposium on the Conversion of Poultry Waste to Energy, Feed, or Fertilizer, Pennsylvania State University, November 6, 1974, p. 17-25.

Descriptors: Methane, Research and development, Chemical properties, Physical properties, Economics.
Identifiers: Production, Poultry manure, Digester.

Few managers have been successful at using poultry manure to generate methane. The methods need more research and field testing. This paper is a collection of what has been published by others and should be used as a guide to begin a discovery in methane production. The different items discussed in this paper are (1) properties of methane, (2) conditions inside the digester, (3) methods and management, (4) physical data, (5) chemical data, and (6) economics. (Cameron-East Central)

### 2463 - A1, B1, D1, E1 200

### BEEF IN CONFINEMENT WORKSHOP,

National Feed Ingredients Association
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, 60 p.

Descriptors: Feedlots, Confinement pens, Cattle, Legal aspects, Design, Costs, Recycling.
Identifiers: Waste management, Pollution control, Deep pit system, Flush flume system, Refeeding.

Legislation has made proper design and management of feedlots a must. Various aspects of beef confinement and waste management were considered in this workshop. Particular attention was given to operation design, costs, and performance. The deep pit system and the flush flume system were considered in detail. The value of recycling and refeeding was also discussed. (Cartmell-East Central)

### 2464 - A1, B1, E2 200

### OUR DEEP PIT SYSTEM,

Pampered Beef Aurelia, Iowa
R. Bryant
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p.6-8, 1 fig.

Descriptors: Confinement pens, Costs, Cattle, Lagoons, Water pollution control, Odor, Ammonia, Performance.
Identifiers: Waste management, Land disposal, Deep pit system, Scrapers.

Dr. Bryant's presentation describes livestock operations in several states, which basically use similar waste management methods for handling cattle manure. A typical system utilizes 3' deep pits beneath slatted floors. These wastes are removed by a scraper system and stored in aerobic lagoons. The manure is then pumped for irrigation of nearby farmland. The scraper system shuts down each year during the 3-4 months of cold weather, but the storage capacity of the pits is designed to handle the waste load during these months. Then as the spring thaw begins, the scraping starts again. It is important to get the manure out from under the cattle during warm weather because ammonia coming up out of the pits has a direct relationship on performance. (Cartmell-East Central)

2465 - A1, B1 200
### NEW FLUSH FLUME SYSTEM WITH DEEP LAGOON,
Estherville, Iowa
J. Greig
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 9-13. 1 fig.

Descriptors: Lagoons, Odor, Feedlots, Confinement pens, Performance, Costs, Irrigation, Water requirement.
Identifiers: Flush flume system, Pollution control, Wind position.

This flush flume system is a mile and a half from town and not in a very good wind position. Because of this it would have presented a problem if the manure was spread on top of the ground. The building is a conventional type confinement and a pollution control structure was installed to catch the runoff water from the outside lots. There is about twenty feet of fall from the creek to a hill where the feedlot sits, and it all drains toward a settling basin and lagoon lot. The water holding capacity is an advantage because in the flush system you have a high water requirement. The advantages of this waste management system are that the cattle are not wet, there hasn't been any trouble with the cattle slipping, and the cost of the entire operation is $80 per head. The only real disadvantage is the problem of steam. (Cartmell-East Central)

2466 - A1, B1 200
### HOW CONFINEMENT FEEDING CAN BE SIMPLE AND EFFECTIVE,
Cattle Feeder—Engineer, Fairfield, Nebraska
R. Kissinger, Jr.
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 16-19. 1 fig.

Descriptors: Confinement pens, Design, Cattle, Ventilation, Temperature, Humidity, Construction, Costs, Flume, Odor, Water requirement.
Identifiers: Flushing, Slats.

This confinement building is 510 ft. x 52 ft. with a feeding area width of 37 ft. 10 inches. There are six pens graduated in size with a total capacity of 1,110 steers at an average weight of 950 lb. Alternate 10 ft. bays on the north side are sliding doors to provide ventilation in the summer. There is a gate on the south side of each pen for removal of any sick cattle. New cattle are loaded through this gate in the east end and fat cattle are shipped from the west end. The ridge opening is 12 inches; a lesser width might lead to difficulty under certain temperature and humidity conditions. In order to reduce construction costs and to utilize the flushing concept without installing dividing walls in a deep pit, a series of inclined cement slabs were used in conjunction with two longitudinal 8 foot wide pits with slats. The anaerobic lagoon is 200 ft. x 200 ft. x 30 ft. maximum depth and holds about 3.5 million gallons of liquid. The mat on the surface varies from zero to four or five feet thick. It is helpful in reducing odors. Flushing is accomplished by throwing a switch. The pit slope varies from 25 per cent to .4 per cent and works quite well. (Cartmell-East Central)

2467 - A1, B1, F2 200
### LEGAL ASPECTS OF WASTE POLLUTION LAWS,
Kansas Livestock Association Topeka, Kansas
V. Huseman
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 27-29. 1 fig.

Descriptors: Legal aspects, Feedlots, Water pollution.
Identifiers: Water Pollution Control Act Amendments of 1972, Zero discharge, Environmental Protection Agency.

The 92nd Congress has passed a Public Law 92-500, better known as the Water Pollution Control Act Amendments of 1972. This represented the first time that the Federal Government got into the business of regulating feedlots as they relate to the environment. Feedlots are specifically defined in the act as a "point sources" of water pollution. The Federal Water Pollution Control Act Amendments made some unprecedented demands on the livestock industry. It states ". . . it is the national goal that the discharge of pollutants into navigable water be eliminated by 1985". That section seems to imply zero discharge. It is impossible to guarantee zero discharge. The Environmental Protection Agency has not developed a set of rules or guidelines for the disposal of wastes, except to recognize that application on agricultural land appears to be the most practical method. The Environmental Protection Agency recommends that operators fill out a Short Form B so that they will be on record with them. (Cartmell-East Central)

2468 - A5, A9, B1, D1, E3 200
### RECYCLING, ITS PROBLEM AND OPPORTUNITIES,
Iowa State University, Ames
R. Vetter
Beef In Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 30-35. 1 fig, 7 tab, 9 ref.

Descriptors: Recycling, Methane, Lagoons, Nutrients, Proteins, Confinement pens, Safety.
Identifiers: Refeeding, Health, Food and Drug Administration

The objective of this review was to relate some of the technologies developed in the area of recycling and to discuss the nutritive value or quality of animal excretory wastes as supplemental nutrients. It is only under conditions where the animals are housed in confined or semiconfined areas that excreta can be effectively utilized for refeeding. The advantages of refeeding lie in the potential conservation of nitrogen, phosphorus and essential mineral elements. As an energy source excreta is of limited value for finishing cattle except for roughage substitution, in which case considerable processing is needed. A disadvantage of refeeding is that variation in waste handling conditions and nutrient content would make ration control difficult. The author feels that smaller midwest farm feedlots will utilize confinement feeding and move in the direction of a total concept of conservation recycling, utilizing a natural harmony of animal, plant, soil, and microbial systems. (Cartmell-East Central)

2469 - B2, D1, E2, E3 200
### ANIMAL WASTE HANDLING AND "CAN THE TAIL WAG THE DOG?",
President, Corral Industries, Phoenix, Arizona
R. E. Bunger
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 40-50. 12 fig, 5 tab.

Descriptors: Costs, Feedlots, Fertilizers, Nutrients, Irrigation, Liquid wastes.
Identifiers: Waste handling, Refeeding, Closed Ecological Cycle, Composting, Land disposal.

Ten thousand head of 800-pound average weight cattle confined in a feedlot will produce 233,600,000 pounds of urine and feces yearly. The cost of removing manure from feed pens to a nearby stockpile will currently run to approximately $1.50 per wet ton under optimum operating conditions, and may run to considerably more in adverse weather conditions. A brief outline of the "Closed Ecological Cycle" under development by Corral Industries of Phoenix is shown. This test indicated a very substantial daily gain average for both groups of cattle—2.88 pounds per day for the control group, and 2.76 pounds per day for the treated (25 per cent recycled solids; 75 per cent grain) group. After the test was completed, the animals were killed and the carcasses were analyzed for grade and yield. The control group had a dressing percentage, or yield, of 60.8 per cent and the treated group had 60.6 per cent. This feed trial was extremely encouraging, and the results have proven the acceptability and efficacy of recycling high levels of recovered solids. It was estimated that this separation system would cost not over $125,000 for 10,000 head of cattle, and would require no more than $200 per day to operate. (Cartmell-East Central)

2470 - B1 200
### WASTE HANDLING AND LAGOON MANAGEMENT,
Minnesota University St. Paul
J. A. Moore
Beef in Confinement Workshop, National Feed Ingredients Association, Des Moines, Iowa, April 4, 1974, p. 51-55. 1 fig.

Descriptors: Lagoons, Feedlots, Design, Chemical properties, Physical properties, Biological properties.
Identifiers: Waste management.

Any beef operator who is considering expanding, redesigning, or rebuilding new facilities should have certain objectives in mind. It is important that these objectives be formalized and listed so that each proposed system can be evaluated as to its potential of successfully meeting the objectives. Considerations that should be evaluated include climate, weather, lot location, nearness to surface and groundwater, soil type and slope, animal numbers and density, pollution control regulations, and nearness to neighbors. Once the objectives of the system have been established, it is important to determine and calculate the properties and characteristics of the material to be handled. The properties and characteristics of animal waste can be broken down into three categories: physical, chemical, and biological. Those aspects of animal waste which may influence design include: collection, storage, treatment and utilization. Advantages and disadvantages are given for the following waste handling operations: liquid collection, storage lagoon, mechanical treatment, and biological treatment. There is no one best system for all operators. (Cartmell-East Central)

2471 - B2 300
### MANURE DISPOSAL LAGOONS,
Agricultural Engineering Research Division, Agricultural Research Service, United States Department of Agriculture, College Park, Maryland
H. J. Eby
Bulletin ARS 42-75, Agricultural Research Service, United States Department of Agriculture, June, 1963, 12 p. 1 fig, 1 tab, 34 ref.

Descriptors: Waste disposal, Lagoons, Aerobic conditions, Anaerobic conditions, Design criteria.
Identifiers: Oxidation pond, Lagoon management, Stabilization pond.

The purpose of this study is to observe manure disposal lagoons in several Eastern and Midwestern States and in Canada and to review the available literature on the subject. There are three types of manure disposal lagoons: anaerobic, aerobic, or a combination of the two. The first type is an open pit or trench and is entirely anaerobic in action. The second type of manure lagoon is also known as an "oxidation pond". The third type of lagoon is referred to as a "stabilization pond" and it produces the least odor of the three types. Explanation is given as to how lagoons work. Factors that need to be considered in constructing a manure disposal lagoon are: (1) Availability of land; (2) Possibility of objectionable runoff that would degrade downstream water; (3) Choice between a stabilization pond or a true oxidation pond; and (4) Enough water being available to maintain the lagoon. Alternatives or modifications of the manure lagoon are discussed. For best results in lagoon management, the following procedures should be followed: (1) Floating material should not be permitted to enter the lagoon; (2) Lagoon loading should be regular and uniform; (3) Constant water depth should be maintained; (4) Weeds should be mowed around the edges of the lagoon; (5) The lagoons should be filled before running manures into it; (6) If algae mats form on the lagoon surface, the surface should be agitated; (7) Petroleum products or other floating products should not be allowed to enter the lagoon. (Penrod-East Central)

### 2472 - A1, B1, D1, E1, F1 200

## MIDWEST LIVESTOCK WASTE MANAGEMENT CONFERENCE,

**Iowa State University**
**Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 184 p. 31 fig, 24 tab, 125 ref.**

Descriptors: Feedlots, Hydrology, Design, Confinement pens, Separation techniques, Anaerobic digestion, Methane, Aerobic treatment, Livestock, Costs.
Identifiers: Waste management, Flushing, Land spreading.

The purpose of the conference was to bring together all aspects of feedlot and animal waste management. Hydrology was discussed by several papers. The hydrologic characteristics of animal waste, design criteria for gutter flushing systems and recirculation equipment design were areas covered in the discussion. Three papers covered livestock waste treatment for both confinement pens and outdoor feedlots. Criteria for the selection of a treatment and handling system for wastes were given. Various building types for confinement housing and their manure handling systems were also discussed. Recommended management practices for the control of waste from outdoor, unpaved feedlots were examined. The effects of waste management systems on the animals involved were presented. Solids separation; aerobic treatment, and the anaerobic digestion of livestock wastes with methane production were discussed thoroughly. Land disposal was examined through the aspects of equipment considerations; agronomic considerations; and the pollution potential of liquid wastes. (Penrod-East Central)

### 2473 - A2, A4, B1 200

## HYDROLOGY OF OPEN FEEDLOTS IN THE CORNBELT,

United States Department of Agriculture, Lincoln, Nebraska
N. P. Swanson
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 11p. 1 fig, 21 ref.

Descriptors: Hydrology, Feedlots, Corn Belt, Rainfall, Snow, Evaporation, Agricultural runoff, Snowmelt, Groundwater pollution.
Identifiers: Solids losses

The purpose of this study is to examine the hydrologic factors of open feedlots in the corn belt. The factors discussed are: temperature, snow, evaporation and rainfall. Since the hydrologic impact of feedlots is on the immediate watershed, hydrology should be considered in feedlot design and management. Rapid drainage of a feedlot is very desirable and is improved by the utilization of mounds and drainways, terraces and basins, and inlet risers with underground drains. Runoff control facilities should be designed for periods of probable high-intensity and maximum intensity precipitation without opportunity for runoff disposal. The study showed that underground water pollution from livestock feeding installations appears to be mostly a local problem with widespread contamination of aquifers not appearing probable. Runoff will be greater and start sooner from a feedlot than from adjacent cropland. There can be appreciable water storage in the soil-manure mixture. The study also indicated that snowmelt runoff may contain 10 to 12 times the chemical oxygen demand and solids content of a rainfall-runoff from the same lots. It was noted that similar runoff facility design capacities can be expected in the Corn Belt states, except in western Kansas, Nebraska, and South Dakota. (Penrod-East Central)

### 2474 - A1, D4, E2 200

## CRITERIA FOR THE SELECTION OF A LIVESTOCK WASTE TREATMENT AND HANDLING SYSTEM,

Department of Agricultural Engineering, Illinois University, Urbana-Champaign
A. J. Muehling
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November, 27-28, 1973. 8 p.

Descriptors: Waste treatment, Waste disposal, Livestock, Confinement pens, Locating, Costs, Lagoons, Odor.
Identifiers: Solid floors, Slotted floors, Pit storage, Hauling, Flushing.

Numerous restricting federal and state regulations covering the treatment and handling of livestock wastes are being enacted. Selection and planning for the waste handling and treatment system must be an integral part of the planning for any confinement operation. This report provides criteria for the selection of a treatment and handling system for livestock waste. There are several factors to consider. Among them are: investment and operational costs; operation size; location of facility with regard to neighbors, the operator's family, soil type and topography, type of facility; existing facilities and equipment; and personal preference. The major systems presently being used are discussed examining the advantages and disadvantages of each. They are: (1) solid floors, manure handled as a solid, (2) slotted floors, pit storage, liquids hauled to the fields, (3) lagoons, (4) slotted floors, pit storage, manure hauled to the fields, an overflow lagoon, (5) slotted floors, a pit with an oxidation ditch and (6) flush system. A comparison table was developed and provided to help the producer rate the systems and decide which one is best suited to his operation. (Penrod-East Central)

### 2475 - A2, B1, E2 200

## OUTDOOR, UNPAVED FEEDLOT MANAGEMENT,

Agricultural Research Service, United States Department of Agriculture, Nebraska University, Lincoln
J. A. Nienaber and G. B. Gilbertson
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 19 p. 2 fig, 4 tab, 16 ref

Descriptors: Feedlots, Design, Agricultural runoff, Drainage, Mud, Snowmelt, Irrigation
Identifiers: Unpaved feedlots, Waste management, Holding pond, Debris basin, Mounding

This report summarizes recommended management practices for control of waste from outdoor, unpaved feedlots. Area requirements for cattle, mound construction, and drainage are discussed in terms of basic requirements for satisfactory feedlot performance. Mud problems must also be considered in the design and management of the feedlot. The three basic components of a runoff control system are: holding pond, debris basin, and disposal area. Suggestions for the design and management of the feedlot, debris basin, holding pond and disposal area are given. Facilities should be planned which provide for a reduction of cattle density to 500 ft$^2$-head during winter operations. Mounds should be constructed parallel to the lot slope and should be connected with the feedbunk and waterer. A minimum of 1.25 ac-in-acre volume should be provided if overflow is collected by the holding pond. If the overflow cannot be collected by the holding pond, 70 per cent of the 10 year, 24-hour storm should be provided for. An excessive snowmelt should be anticipated every 2-3 years; although reduced cattle density will relieve the resulting muddy conditions. There should be a minimum holding pond storage volume of 100 per cent of the 10-year, 24-hour storm. An existing irrigation system should be used if possible; otherwise, the minimum area for liquid disposal is ½ acre of pasture per acre of feedlot. (Penrod-East Central)

### 2476 - B1 200

## CONFINEMENT SYSTEMS AND MANURE MANAGEMENT: STATE OF THE ART

V. M. Meyer
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 10 p. 17 fig.

Descriptors: Confinement pens, Livestock, Design.
Identifiers: Waste management, Solid floors, Slotted floors, Stall barn, Free stall, Pits.

This report lists various building types and their manure handling systems for swine, beef, dairy, poultry, and sheep. The building types for swine were divided in three categories: farrowing, nursery and finishing. For farrowing, buildings housing solid floor with or without bedding, and slotted floor, both total and partial, were listed along with their manure handling systems. A similar setup was provided for the nursery. For finishing swine, outside concrete and cold and warm building were given with their systems. The building types listed for beef were solid and slotted floors. Dairy livestock buildings included stall barn and free stall. For poultry, three building types were listed: deep pit, liquid, and shallow pit. Sheep were listed only with solid building types. (Penrod-East Central)

### 2477 - A1, B1 200

## EFFECTS OF WASTE MANAGEMENT SYSTEMS ON THE ANIMAL'S ENVIRONMENT,

Department of Agricultural Engineering, Nebraska University, Lincoln
J. A. DeShazer
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 5 p. 1 tab, 11 ref

Descriptors: Confinement pens, Farm management, Waste storage, Ventilation, Odor, Humidity, Temperature, Hydrogen sulfide, Ammonia.
Identifiers: Waste removal, Aerobic pit, Anaerobic pit, Slotted floor

A major concern of the livestock environmental engineer about waste handling techniques is how these systems affect the gaseous and bacterial environment of livestock. The objective of this study is to describe the effects of such techniques on the animal. Two systems under consideration are the storage of the waste within the building and the frequent removal of wastes from the building. A comparison of the hydrogen sulfide and ammonia concentrations of an open-front swine building and an enclosed swine building was made in the summer of 1971 at the University of Nebraska. Results showed that the level of both gases was approximately the same. A study of pit ventilation in swine confinement buildings versus side wall ventilation with no pit ventilation during the spring showed that there was no difference in hog performance. More sneezing and coughing occurred among pigs kept over anaerobic pits than among those kept over aerobic pits, according to a Purdue University study. Hog management for proper dunging habits is important in odor control of the hog's environment. The waste handling system can affect the thermal environment of the animals, with humidity probably being the major concern. The study showed that the performance of livestock seems not to be affected by either the treatment of waste within the building or frequent removal of waste from the building. (Penrod-East Central)

### 2478 - B1, D2 200

### SOLIDS SEPARATION,

Department of Agricultural Engineering, Wisconsin University, Madison
R. E. Graves
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 8 p. 7 ref.

Descriptors. Separation techniques, Solid wastes, Slurries, Settling basin, Flotation, Centrifugation, Moisture content.
Identifiers: Screening, Settling pond, Vacuum filtration.

Manure and water slurries resulting from hydraulic cleaning or transport must be handled and-or treated. The solid material in such slurries ranges from dissolved salts and soluble organic matter to hair, feathers, unused feed, and stones. Since solids can be separated from manure and water slurries, this can be a useful step in an overall animal waste treatment system. Solids separation may be achieved through use of one of the following systems: settling, screens, vibrating screens, stationary sloping screens, other screens, flotation, centrifugation, and vacuum filtration. Each of these methods is explained. When using solids separation and concentration for waste handling and treatment systems, the livestock owner must keep in mind the cost, complexity, and the overall goal of the waste management system. (Penrod-East Central)

### 2479 - D4, F1 200

### ANAEROBIC DIGESTION OF LIVESTOCK WASTES AND THE PROSPECTS FOR METHANE PRODUCTION,

R. J. Smith
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28 1973, 30 p. 2 fig. 5 tab. 26 ref.

Descriptors: Anaerobic digestion, Livestock, Methane, Costs, Toxicity, Temperature.

This paper describes the processes involved in anaerobically digesting livestock wastes to produce methane. Anaerobic digestion of livestock wastes for methane production is technically quite feasible, but at present it is not economically feasible. Besides the high capital investment for the methane production itself (which is only a partial waste stabilization process), any realistic anaerobic digester must be followed by further processes of waste stabilization and these may be expensive, or they may consume power, thus reducing the amount available for sale. The author feels that a resurgence of interest in methane production will occur on the part of the utilities (as opposed to individual producers) if and when natural gas becomes a scarce commodity. It should then be possible to consider funding, using tax money since the gas production would have some aspects of social service. (Penrod-East Central)

### 2480 - A6, B3, D4 200

### AEROBIC TREATMENT OF LIVESTOCK WASTES,

Purdue University, Lafayette, Indiana
J. C. Nye
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 11 p. 2 tab, 2 ref.

Descriptors: Aerobic treatment, Livestock, Design, Organic acids, Nitrogen, Hydrogen sulfide, Oxidation reduction potential, pH.
Identifiers: Oxidation ditch, Mechanically aerated lagoon, Oxidation pond, Aerators.

The purpose of this report is to provide a brief description of design procedures for aerobic treatment facilities which can be used in consultations with individual livestock producers. Basically, there are three approaches to aerobic treatment. They are: (1) oxidation ditch, (2) mechanically aerated lagoon, and (3) oxidation pond. Each of these methods is discussed. A major problem with an aerobic treatment process is the breakdown or overloading of the aeration system. When this happens, the aerobic bacteria may have competition from other organisms which utilize other compounds in their metabolic processes. If the aeration equipment fails to operate and the aerobic process becomes anaerobic, the organisms will first use nitrate as an electron acceptor in their metabolism. Sulfate may also be utilized releasing hydrogen sulfide gas which can kill livestock. A final substitute for oxygen may be an organic compound which can result in methane production. The terminal product of the oxidation-reduction process is controlled by the ORP (Oxidation-Reduction Potential) of the liquid. This means that when aerators break down, it is important that they be repaired or replaced as soon as possible to prevent ORP from dropping to the level where odorous gases are given off. A shift in pH may also result during these anaerobic conditions from the production of organic acids. This shift may cause flaming when the aerators are restarted. A final decision on equipment should be based on availability of replacement parts and reliability. (Penrod-East Central)

### 2481 - B2 200

### FLUSH GUTTER SYSTEMS--CURRENT IOWA INSTALLATIONS,

S. W. Melvin, J. C. Lorimor, D. O. Hull
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 10 p. 3 fig, 7 ref.

Descriptors: Iowa, Hydraulic systems, Anaerobic digestion, Lagoons, Confinement pens.
Identifiers: Flush gutter systems, Pits, Slotted floors Flumes.

Several different types of hydraulic flush confinement beef buildings have been, or are being constructed in Iowa. Many questions concerning their operation remain unanswered. All of these systems are utilizing lagoons, for treatment and storage prior to recycling or disposal. Anaerobic lagoons could well be the limiting component of these systems. Only time will answer some of the questions concerning management and operation of each of these systems. Engineers will be required to develop some of these concepts even further as confinement feeding of beef cattle continues. (Melvin)

### 2482 - B2 200

### HYDRAULIC CHARACTERISTICS OF ANIMAL WASTE,

Department of Agricultural Engineering, Minnesota University, St. Paul
J. A. Moore
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 18 p. 2 fig, 2 tab, 24 ref.

Descriptors: Hydraulic systems, Animal wastes, Design, Moisture content, Viscosity, Pumping, Waste storage, Waste treatment.
Identifiers. Solids content, Flushing, Settling, Agitation, Collection, Utilization, Total solids.

Hydraulic characteristics must be considered when planning or managing an animal waste system. The four system components are collection, storage, treatment, and utilization. Not all of these components are included in every system. The purpose of this report is to examine the hydraulic characteristics of animal waste and their application to the engineering properties of materials as applied to designing and-or managing livestock wastes. Hydraulic characteristics discussed are: moisture content and its measurement, flushing, solids content and viscosity, settling, agitation, and pumping. In the measurement of moisture content, calculated total solids must be related to the fluid characteristics. Other factors besides particle size need to be considered in settling evaluation. They include precipitation, amount of solids and removal, and water-manure ratio. Study data indicate that as the quantity of waste hay, silage and green shop entering increases, agitation becomes more difficult. Hydraulic characteristics and many other factors combine to determine the design and management of a livestock waste system. (Penrod-East Central)

### 2483 - B2 200

### DESIGNING GUTTER FLUSHING SYSTEMS,

Missouri University Columbia
R. M. George
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 14 p. 5 tab, 3 ref.

Descriptors: Design criteria, Hydraulic transportation, Missouri, Mannings Equation, Flow, Slope, Velocity.
Identifiers: Gutter flushing, Instant lagoon concept, Slats, Swine

Gutter flushing systems seem to work well with the components of animal waste management systems using anaerobic lagooning and irrigation disposal of the effluent. Such systems have minimum odors, low cost, and the flushing is most consistent with good lagoon management. The purpose of this report is to provide parameters for designing gutter flushing systems. The report provides a procedure for designing open gutter and gutter under slats flushing systems for swine. The method also works well for Beef Slope-Slot Systems. A new variation of hydraulic transport called "Instant Lagoon Concept" is described. This concept says if .0027123 of the lagoon design volume is circulated daily through a smaller pit or basin, the biological activity would be the same if the same amount of manure were placed continuously in the larger lagoon. Supporting design data derived from operating Missouri systems are presented. The selection of design parameters is examined and the depth of flow, width of channel and hydraulic radius are discussed. Design philosophy and procedures are given. Some systems and their application are explained. (Penrod-East Central)

### 2484 - B2 200

### RECIRCULATION EQUIPMENT DESIGN AND SELECTION,

Department of Agricultural Engineering, Iowa State University, Ames
G. B. Parker

Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 7 p.

Descriptors: Equipment, Design, Hydraulic transportation, Recycling, Lagoons, Pumps.
Identifiers: Flushing, Channel design, Piping

Large quantities of a relatively "clean" pumpable liquid are needed for hydraulic transport of animal wastes from a confinement system. Although the cost of great quantities of fresh water is high, the main problem is the hauling and disposal of the resultant contaminated liquor. The purpose of this study is to investigate recycling as a means of supplying the quantities of fluid required without increasing the volume of waste to be disposed of. So far only two economically feasible waste handling systems applicable to hydraulic transport have been developed. They are the aerobic lagoon or basin and the anaerobic lagoon. The anaerobic lagoon eliminates most of the solids because nearly all solids settle to the bottom where they are anaerobically digested at varying rates. However high chemical instability has been encountered as a significant problem with this system. In designing a hydraulic transport system, channel design, method of flushing, pipes, and the type of recycle pump to be used must be decided upon. The author's experience with various brands and models of pumps is given. (Penrod-East Central)

**2485 - A1, B1, E2 200**

### AGRONOMIC CONSIDERATIONS OF ANIMAL WASTE DISPOSAL,

Extension Agronomist, Iowa State University, Ames
R. D. Voss
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 7 p. 5 ref.

Descriptors: Waste disposal, Agronomy, Crop response, Nitrogen, Phosphorus, Nutrients, Salts.
Identifiers: Land disposal.

In this paper the assumption is made that the soil's usefulness for crop production is to be maintained. The primary concern is if land disposal of animal wastes is the ultimate goal, how much can be applied without causing short or long term problems. Short term effects would include: salt and toxic effects on germination and growth of plants, loss of nitrate in drainage water, crop quality, crop yields, and surface runoff. Long term effects would include: crop productivity, accumulative salt effect on crops, dispersal of soils by accumulation of sodium, and nutrient imbalance due to phosphorus or other element buildup. Suggested optimum rates of application of animal wastes for efficient utilization of the nutrients by harvested crops are 10 to 20 tons per acre on a fresh weight basis according to several authorities. Plans for any animal waste handling system should include provision for waste disposal. The plans should be according to guidelines which, hopefully, will include agronomic considerations. (Penrod-East Central)

**2486 - A1, B2, E2 200**

### SUMMARY OF KANSAS' EXPERIENCE WITH LIQUID WASTE SPREADING,

Department of Agricultural Engineering and Agronomy, Kansas State University
H. L. Manges, L. S. Murphy, and W. L. Powers
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973, 9 p. 2 fig, 3 tab, 3 ref

Descriptors: Kansas, Agricultural runoff, Lagoons, Fertilizers, Nutrients, Crop response, Salt tolerance, Chemical properties.
Identifiers: Land disposal, Guidelines.

The cattle feeders of Kansas are controlling surface water pollution by catching and storing feedlot runoff in lagoons. In Western Kansas, collected runoff is evaporated since evaporation greatly exceeds rainfall. Remaining feedlots resort to land disposal of the runoff. Since land application of runoff hasn't been practiced very much, little is known about application rates. The purpose of this report is to examine and determine the pollution potential from high application rates of feedlot wastes to land. The study showed that snowmelt runoff pollutants concentration is 2 to 2½ times that of rainfall. Runoff storage in lagoons results in pollutants concentration increasing with the evaporation of pure water. Recommendations for runoff analyses are given. If runoff is applied as a fertilizer it should be applied at rates necessary to supply the nutrients required by the crop growth. Fertilizer recommendation for the area could be used as one criteria. Guidelines and recommendations were given for feedlot runoff application onto land. Average annual application rates of 5, 5 and 9 inches in 1971, 1972, and 1973, respectively resulted in top corn forage yields in Kansas. Salt buildup in the soil will eventually determine application rates. (Penrod-East Central)

**2487 - B2, E2 200**

### RETURNING ANIMAL WASTES TO THE LAND-EQUIPMENT CONSIDERATIONS,

Missouri University, Columbia
M. Peterson
Presented at Midwest Livestock Waste Management Conference, Iowa State University, Ames, November 27-28, 1973. 11 p. 2 fig, 2 tab.

Descriptors: Equipment, Design criteria, Pumps, Pipes, Irrigation, Slurries, Lagoons, Volume.
Identifiers: Land disposal, Consistency

Large waste disposal and potential pollution problems are created by the concentration of livestock in small areas. The purpose of this report is to describe developments in animal waste systems including: collection, pumping, and distribution systems. The initial considerations of planning a livestock operation are location and good design and management. Design considerations include: (1) Volume of wastes produced, (2) Consistency of wastes, (3) Pump materials and seals, (4) Pumping unit controls, (5) Piping systems, and (6) Choosing an irrigation disposal system. Lagoon effluent, or other fluid wastes containing less than 5 per cent solids can be handled by most irrigation systems: ditches with spile tubes, gated pipe, hand-carry sprinkler systems, traveling gun systems, side-roll sprinkler systems and center pivot sprinklers. Liquid slurries, having up to 14 per cent solids, may be handled only by a hand carry gun sprinkler, liquid manure tankwagon, or a traveling gun sprinkler. Alternative ownership schemes for livestock producers reluctant to invest large amount of money in irrigation disposal equipment initially are provided. Management is the key to making a well-designed system work. (Penrod-East Central)

**2488 - A5, B2, F2 200**

### PERSONAL SIDELIGHTS AND OBSERVATIONS OF THE HBI TRIAL,

L. Harper
Missouri Ruralist, Vol. 110, No. 7, p. 38-39. April 12, 1969

Descriptors: Odor, Lagoons, Zoning
Identifiers: Lawsuits, Swine industry

This report examines the Bower vs. Hog Builders Incorporated (HBI) trial and its impact on livestock producers. The plantiffs claimed that their lives had been made miserable either by intent or willful negligence on the part of HBI. The point was made that anaerobic lagoons were never intended to be waste disposal structures and that odor was a natural characteristic of anaerobic lagoons. An important question that the trial raised was: "Who does the livestock man turn to for advice and recommendations with some assurance of protection against a lawsuit?" Another point that needed to be clarified was whether or not a hog operation—even a large hog operation—can be classified as a heavy industry when zoning regulations are being applied. These and several other questions were brought out by the HBI trial which awarded the plaintiff's damages. This trial points to need for livestock producers to be aware of and to control pollution from their facilities so that environmental quality can be preserved and lawsuits can be avoided. (Penrod-East Central)

**2489 - B1 600**

### PLANNING CONSIDERATIONS FOR CONFINEMENT SWINE FACILITIES,

Hog Product Manager, Big Dutchman, Zeeland, Michigan
B. Engle
Presented at the 1972 Winter Meeting, American Society of Agricultural Engineers, Chicago, Illinois, December 11-15, 1972, Paper No. 72-919, 12 p. 4 fig, 4 tab.

Descriptors: Confinement pens, Planning, Design, Ventilation, Temperature.
Identifiers: Swine, Comfort zone

The purpose of this report is to present management tools developed by Big Dutchman for commercial hog producers that may be utilized in planning hog facilities. The author stresses the necessity of having better managers in order to obtain the best results from facilities improved by technology. Since hogs are very sensitive to temperature, the facilities discussed are designed to maintain the temperature within the range of 50 degrees to 80 degrees. The major factor holding back acceptance of confinement facilities is poor ventilation. One difficulty in properly ventilating a building is that hogs do not all require the same temperature and air movement. Negative air systems are favored by the author and his company for maintaining the air patterns that provide oxygen, clean out foul air, promote good dunging habits, and keep temperature variations at a minimum. These systems are discussed. The various side issues to ventilation that affect environmental control are: pig brooding, type of penning, long narrow pens, comfort zone, per cent of slats, and evaporative cooling. Proper planning is essential in keeping labor at a minimum and in promoting proper production flow. Methods of grouping sows for breeding and continuous farrowing, are examined. Clean up in the farrowing units is also discussed. A simple method of planning a hog facility so that expansion is possible by simply adding on necessary buildings is given. (Penrod-East Central)

**2490 - A1, E2 100**

### EFFECTS OF BEEF-FEEDLOT MANURE AND LAGOON WATER ON IRON, ZINC, MANGANESE AND COPPER CONTENT IN CORN AND IN DTPA SOIL EXTRACTS,

Departments of Agronomy and Agricultural Engineering, Kansas State University, Manhattan
G. W. Wallingford, L. S. Murphy, W. L. Powers, and H. L. Manges
Soil Science Society of America Proceedings, Vol. 39, No. 3, p. 482-487, May-June, 1975. 6 fig, 4 tab, 25 ref

Descriptors: Feedlots, Cattle, Crop response, Copper, Iron, Zinc, Manganese
Identifiers: Land disposal, Manure, Lagoon water, DTPA, Soil Extracts, Nutrient availability

The effects of beef-feedlot manure and lagoon water on DTPA-extractable iron, zinc, manganese, and copper of a silty clay loam soil, concentrations of these elements in corn (Zea mays L.) forage and leaf tissue, and their uptake by corn forage were studied in the field. The pH of the soil studied was not appreciably changed by the manure applications during the two years of the study. However, the soil availability (as measured by the DTPA extraction) of Zn, Fe, Mn, and to a lesser extent, Cu was increased. Manure applications enhanced corn-leaf and forage concentrations of Zn, and Mn and corn-forage uptake of Mn. There was a consistently high correlation of the Mn plant data with the cumulative manure applied. Manure applications were shown to increase the availability of Zn and Mn in the soil studied but did not consistently affect corn concentrations of Fe and Cu and uptake of Fe, Zn, and Cu. Increased DTPA-extractable Fe, Zn, and Mn were found in soil cores taken from plots that had received two years of beef-feedlot lagoon water; Cu was unaffected. This study showed that lagoon water effectively increased the availability of Fe and Mn. The study also indicated that feedlot wastes were sources of the trace elements Fe, Zn, and Mn. Annual applications of either manure or lagoon water could correct the soil deficiencies of these micronutrients. (Penrod-East Central)

### 2491 - A1, B2, E2 100

### SOME EFFECTS OF BEEF-FEEDLOT EFFLUENT APPLIED TO FORAGE SORGHUM GROWN ON A COLO SILTY CLAY LOAM SOIL,

Former Research Assistant, Nebraska University, Lincoln
J. E. Sukovaty, L. F. Elliott, and N. P. Swanson
Journal of Environmental Quality, Vol. 3, No. 4, p. 381-388, October-December, 1974. 6 fig, 6 tab, 30 ref.

Descriptors: Feedlots, Effluent, Agricultural runoff, Crop response, Forage sorghum, Nutrients, Cations, Phosphorus.
Identifiers: Application rates, Soil solution, pH.

The effects of beef feedlot effluent and water additions to a forage sorghum were compared during two consecutive growing seasons. Increased forage production in both years of the study resulted from the addition of beef-feedlot effluent. The highest yield for both years was obtained from an application rate of 25 cm-year (2.5 cm-week) and this was significantly higher than yields from other treatments during the second year. The above application rate may be near the optimum for maximum production. Yields were not increased by a higher application rate of 50 cm-year (5 cm-week). However, no major forage yield reductions were observed from the higher application rates. There was a slight additive result noted on the $NO_3$--N content of the plant material as a result of the effluent addition. No appreciable change in soil $NO_3$-N concentrations, as affected by effluent addition, was indicated. The concentrations of Ca, Mg, and Na, and K in the forage sorghum were not affected by the application of beef-feedlot effluent. During the 2-year study, phosphorus increased in the surface 10 cm of the soil as the effluent application was increased. A slight increase of Ca, Na, and K was noted in the soil solution as a result of effluent addition. Few problems in crop production should be offered by feedlot-effluent disposal at the crop nutrient requirements. It was indicated that phosphorus would be the limiting factor in effluent application. (Penrod-East Central)

### 2492 - A1, B2, E2 600

### ANIMAL WASTE MANAGEMENT THROUGH CONTINUOUS SUBSURFACE INJECTION,

Agricultural Engineering Department, Colorado State University, Fort Collins
R. C. Ward, J. L. Smith, and D. B. McWhorter
Presented at the 1975 Annual Meeting, American Society of Agricultural Engineers, University of California, Davis, June 22-25, 1975, 15 p. 3 tab, 8 ref.

Descriptors: Waste disposal, Equipment, Costs, Environmental effects, Odor, Aesthetics, Insects.
Identifiers: Subsurface injection.

This paper describes an animal waste management program for liquid manure systems which overcomes many economic problems and which satisfies environmental constraints. The described program utilizes a conventional liquid manure system from the feedlot to the storage pit, with a continuous subsurface injection system being used for actual disposal. This continuous system overcomes many of the limitations associated with a batch (tank wagon) operation. The main purpose of subsurface injection is to thoroughly mix the manure with the soil, utilize minimum power, and not have the manure exposed directly to the air. Such disposal permits rapid drying and repeated applications at frequent intervals. The manure is covered by the soil at such a depth that aerobic conditions prevail, which greatly reduces the odors and insects normally associated with land disposal of manure. The waste management operations aesthetics are greatly improved for the nearby neighbors and the dairy farmer. An economic comparison of the system with other systems is given and environmental constraints on the system are briefly discussed. It was concluded that the continuous subsurface injection system offers an environmentally sound method of disposing of animal wastes and reduces labor costs. (Penrod-East Central)

### 2493 - D4, E3 400

### FUEL FOR THOUGHT: IS STOCKPILED ENERGY GOING TO WASTE?,

J. L. Parker
Western Livestock Journal, Vol. 52, No. 26, April 1974, p.66-68, April, 1974. 4 fig.

Descriptors: Methane, Fertilizers, Feedlots.
Identifiers: Bio-gas digester.

This report examines the production of methane and ammonium type fertilizers from controlled natural digesters. The process of gas production is one of anaerobic decay. Utilizing this process for reclaiming concentrations of animal waste is becoming more economically feasible since natural gas shortages are affecting fertilizer production. This form of natural bacterial digestion is a biological process which achieves maximum results when the waste material is maintained at a temperature range of 75 to 90 degrees F. If managed properly, it can be free of air pollution. The use of feedlot manure in this process is logical since in terms of purity, feedlot manure is an unadulterated product of uniform consistency in both gas and fertilizer values. From one pound of dry feedlot manure, approximately one cubic foot of gas averaging 70 per cent methane can be generated. The heat value of the gas produced is about 650-700 B.T.U.s per cubic foot. This compares with 450 B.T.U.s per cubic foot of coal gas generated in English gas plants. The digested sludge contains nitrogen mainly in the form of ammonium. By drying the digested sludge as a filter cake, a concentrated fertilizer is produced. The most successful continuous cycle bio-gas digesters have been in the form of horizontal tanks divided by a half wall down the center. This type seems to yield maximum production of gas while achieving maximum reduction of the wastes and consequent increase in concentrated fertilizer values. (Penrod-East Central)

### 2494 - A1, A3, E2 300

### TREATMENT AND ULTIMATE DISPOSAL OF CATTLE FEEDLOT WASTES,

Kansas State University, Manhattan
H. L. Manges, R. I. Lipper, L. S. Murphy, W. L. Powers, and L. A. Schmid
Environmental Protection Agency Report No. EPA-660-2-75-013, June, 1975, 138 p. 44 fig, 28 tab, 78 ref.

Descriptors: Feedlots, Waste treatment, Waste disposal, Anaerobic lagoon, Water pollution, Rainfall, Soil chemistry, Soils.
Identifiers: Land disposal, Water pollutants, Great Plains, Environment.

A study was conducted to determine the characteristics of beef feedlot wastes, both runoff and manure, and the optimum application rate of these wastes to land. The project was located at a commercial beef feedlot in southcentral Kansas. Characteristics of beef feedlot wastes varied widely with season. Near maximum corn forage yields, without excessive accumulation of salt in the soil, were obtained from waste application rates necessary to meet nitrogen fertilizer recommendations. At these waste application rates, basic intake rate of water into the soil was increased. Net income from irrigated corn production was sufficient to make application of feedlot manure with disposal as the main objective unprofitable. Land application rates of beef feedlot wastes should be based upon the results of laboratory analyses of wastes from each feedlot. Feedlot wastes should be applied at rates necessary to meet nitrogen fertilizer recommendations. A salt-alkali test should be made annually on the surface soil to monitor changes in soil salinity levels. (Manges-Kansas State University)

### 2495 - A1, E3 300

### RESEARCH STATUS ON EFFECTS OF LAND APPLICATION OF ANIMAL WASTES,

Kansas State University, Manhattan
W. L. Powers, G. W. Wallingford, and L. S. Murphy
Environmental Protection Agency Report No. EPA-660-2-75-010, June, 1975, 96 p. 5 fig, 13 tab, 223 ref.

Descriptors: Soil disposal fields, Agricultural runoff, Research and development.
Identifiers: Groundwater pollution, Soil contamination, Soil properties, Application rates.

The primary purpose of this report was to review the literature and analyze research needs on the effects of land application of animal waste. An additional purpose was to assemble published information on application guidelines for animal waste. Included in this report are information on the characteristics of waste, effects of waste on soil and water near application sites, application rates, application techniques, and research needs. This report is organized into six main topics: (1) climate, waste, and soil classification; (2), waste composition; (3), effect of waste on the environment; (4), application rates based on waste constituents; (5), application techniques; and (6), research needs. The climate, waste, and soil classification systems were developed to allow comparison of the effects of animal waste applications on land in various parts of the country. The composition of the waste in each climate was tabulated and values compared. Comparisons between climatic regions were not possible because of the large variability within regions. Because of this variability no average composition for a given waste in a given climatic region was possible. The effect of the waste on the environment was measured in terms of the possible final disposition of the waste constituents. These constituents could accumulate in the soil, move to the ground water, run off the soil surface, or be taken up by plants. Attempts were made to assemble application guidelines from the various parts of the country. (Powers-EPA)

### 2496 - A5, A8, E2, D3, D4, E2 300

### K.S.U. AEROBIC SWINE WASTE HANDLING SYSTEM (6 YEARS OF PROBLEMS AND PROGRESS),

Department of Animal Science and Industry, Kansas State University, Manhattan
B. A. Koch, R. H. Hines, G. L. Allee, and R. I. Lipper
Unpublished Paper No. 20-15, Kansas State University, Manhattan, 15 p. 3 fig, 3 tab.

Descriptors: Kansas, Aerobic conditions, Dusts, Costs, Odor.
Identifiers: Swine, Oxidation waste disposal system, Flies, Foam control.

The purpose of this report was to evaluate the use of an aerobic waste-oxidation system for handling swine wastes. The main operational problem of this unit was a layer of foam that did not circulate and which, therefore, dried into a thick crusty layer on the surface of the liquid in the pits. The majority of the additives used to successfully break up the foam alleviated the immediate problem but none seemed to prevent the formation of more foam. By accident, two effective foam dispensers were found. They were Foremost-Soweena (a milk replacer for baby pigs) and Ferma-Grow (a fermentation feed additive). Poloxalene (active ingredient in Bloat Guard) was also found to be an effective foam-control agent. A noticeable odor problem (probably H2S) was not overcome by the foam dispersers. It was controlled and eliminated by regularly adding small amounts of Puritan Liquid Live Microorganisms to each pit. A dust problem was also solved. Overall, the unit is functioning satisfactorily with minimum maintenance and supervision. There are low labor requirements and no odor problems. The application of waste fluid to fields can be done any time the soil isn't too wet (no complaints from neighbors regardless of wind direction or humidity conditions). Pigs are performing satisfactorily in the unit, flies are easily controlled and suitable sanitation is easily maintained. However, operational costs have been higher than desired. (Penrod-East Central)

**2497 - A1, B1, F1, F2 300**

### AGRICULTURE AND THE POLLUTION PROBLEM,

J. C. Street

Utah Law Review, p. 385-460, June, 1970. 16 ref.

Descriptors: Agriculture, Water pollution control, Water pollution sources, Organic wastes, Economics, Regulation

Identifiers: Pollution

Agricultural practices are contributing significantly to environmental pollution. Animal and domestic wastes have a pronounced pollutive effect, especially when discharged directly into rivers and streams. Such discharges raise the nitrogen and phosphorus levels of the water and may result in increased concentrations of disease organisms and in undesirable eutrophication of ponds and lakes. In addition, there is the problem of domestic wastes from rural homes, most of which are not equipped with advanced septic systems. The discharge of organic waste matter from the industrial processing of agricultural commodities raises the biochemical oxygen demand of the water into which it is discharged. Over-application of fertilizer and consequent excessive nutrient leaching or loss by runoff is another problem. A small increase in the concentration of phosphorus from fertilizers may result in an algae-bloom and eventually a fouled, oxygen-deficient, stagnant system. Regulations have been put forth in attempts to maintain the quality of the country's waters, but the small producer has not yet been compelled to comply because of lack of resources for enforcement and because of the small farmer's inability to absorb the added costs. (Johnson-Florida)

**2498 - D2, E3, F1 300**

### SYNTHESIS GAS FROM FEEDLOT MANURE: A CONCEPTUAL DESIGN STUDY,

Department of Chemical Engineering, Kansas State University, Manhattan

C. R. Engler, W. P. Walawender, and L. T. Fan

Contribution No. 37, Department of Chemical Engineering, Kansas Agricultural Experiment Station, Manhattan, December 1, 1973. 34 p. 7 fig. 7 tab. 51 ref.

Descriptors: Design, Equipment, Feedlots, Costs, Chemical properties, Moisture content, Transportation

Identifiers: Pyrolysis

This study presents the development of a conceptual plant design to process 1000 T-D (tons-day) of raw manure (50 per cent moisture) to yield a synthesis gas composed of CO, $H_2$, and $CH_4$. Estimated capital investment and operating costs for the plant are presented along with the results of sensitivity analysis, i.e. studies of the effects of variations in the size of the plant, raw manure moisture content, manure composition, and transportation costs on the cost of the synthesis gas. The capital investment required for the plant was estimated at $6.07 MM (million), with annual operating costs at $2.54 MM. It was determined that for a 15 per cent return of investment at current gas prices, the 1000 T-D plant would have to receive a credit of approximately $3.65-ton. To make manure pyrolysis economically feasible, improvements in the process or significant changes in the cost for producing synthesis gas by conventional methods would be needed. (Penrod-East Central)

**2499 - D2, D3, E3 400**

### PAUNCH FEEDING NOW PROFITABLE,

Calf News, Vol. 13, No. 8, p. 14-15, 30, August, 1975. 6 fig.

Descriptors: Economics, Cattle

Identifiers: Refeeding, Paunch manure, Blood, Chemical treatment, Corral industries

The economic feasibility of paunch feeding is being investigated in Phoenix, Arizona where Corral Industries has developed a new two-phase system for recovering the liquids and solids from paunch and making an acceptable cattle feed. Preliminary trials have indicated acceptance of up to 70 per cent of the total diet. The paunch is collected and extruded. Tramp metals are magnetically removed from the solids and then the material is chemically treated to kill enteric bacteria, to mask odor, to create a residual kill of bacteria, and to add food value. The treatment also degrades the fiber to make the material more available the second time around. Although the initial operation was a mobile unit, a full-scale model is now operating to get some of the bugs out of the designing and handling aspects of the operation. Through the process, blood from the packing house becomes a valuable feed supplement along with the roughage. Basic equipment for recovery is briefly discussed. According to test results, a 1,000 head kill should feed 1,000 head in the feedlot. The pay back period of the operation would be a little over two years. However, if the blood recovery system were added it would take only a year. (Penrod-East Central)

**2500 - D4, E3 100**

### THE BIO-GAS PLANT: GENERATING METHANE FROM ORGANIC WASTES,

R. B. Singh

Compost Science, Vol. 13, No. 1, P. 20-25, 1972. 3 fig.

Descriptors: Recycling, Organic wastes, Methane, Design, Slurries, Fermentation

Identifiers: Bio-gas plant

Bio-gas plants can be designed to work efficiently and to meet energy needs effectively in nearly any instance where natural gas can be used. Bio-gas is very similar to natural gas in composition and can be produced from farm wastes. The size of a bio-gas plant depends upon the production requirement and the amount of raw material available. Other considerations are the suitability of the raw material, the temperature of the operating cycle and the length of the operating cycle. Small gas plants can produce up to 500 cu. ft. of gas per day, and large plants can produce up to 9,000 cu. ft. per day. Materials used are usually cow dung and vegetable wastes with a carbon to nitrogen ratio of optimally 25:1. The operating cycle works best when warm and should be insulated if installed in colder climates. Agitation is not always required for small plants but is usually mandatory for large plants. The bio-gas is collected by a metal drum inverted over the fermenting slurry. The pressure keeps the gas from escaping, and the gas collects in the drum for storage. Bio-gas plants can be built above ground or under ground. Above ground design provides for a radiant heat source from the sun, while under ground design assists the gravity feed system for slurry to enter the plant. (Sanders-East Central)

**2501 - D1, E3, E4, F1 400**

### MANURE PROCESSING YIELDS PRODUCT USED IN PLASTICS,

J. D. Kendall, Editor

Feedstuffs, Vol. 47, No. 32, p. 12-13, August 11, 1975.

Descriptors: Recycling, By-products, Feedlots, Texas, Fertilizers, Gases, Plastics, Pipelines, Cattle, Economics

Identifiers: Ethylene

In research with the objective of showing that feedlot waste could be converted to synthetic gas for producing fertilizer, Dr. James G. Halligan, Texas Tech chemical engineer, found that cattle manure yields ethylene which is used in plastics manufacturing. R. Douglas Kreis, project officer of the EPA agricultural waste research program at Ada, Oklahoma, stated that, on the basis of the Texas Tech research, ethylene could be recovered at the rate of 180 lbs. per dry ton of beef cattle manure. The process seems to be economically feasible with the use of pipelines to transport the gas, and it appears to be a constructive solution to the disposal of the 2-4 million tons of manure produced annually on the Texas plains. Other experimentation is continuing to determine uses for other products yielded from this process—other gases, tars, wastewater, and an inert residue containing ash. It is felt that the ash might be used for playa lake fills, road fills, or in construction. (Sanders-East Central)

**2502 - A2, A3, B1, 100**

### A SURVEY OF EFFECTS OF ANIMAL WASTES ON STREAM POLLUTION FROM SELECTED DAIRY FARMS, ,

Department of Dairy Science, Clemson University, Clemson, South Carolina

J. J. Janzen, A. B. Bodine, and L. J. Luszcz

Journal of Dairy Science, Vol. 57, No. 2, p. 260-263, February, 1974. 3 tab, 5 ref.

Descriptors: Water pollution, Dairy industry, Sampling, Coliforms, South Carolina, Biochemical oxygen demand, Chemical oxygen demand, pH, Nutrients

A study was conducted in South Carolina in which water was sampled from streams adjacent to selected dairy farms. The waste management systems utilized by these farms were lagooning, dry disposal, and liquid manure handling. Stream samplings were taken above, adjacent to, and below the major animal waste drainage areas. It was determined that 42 per cent of the selected farms contributed in varying amounts to a reduction in stream water quality. Twenty-six per cent of these farms contributed to significant increases in fecal coliform concentrations. Studies are underway to determine the effects of depth, site, and frequency of sampling on measures of stream water quality. Water quality data is also being collected for streams draining virgin lands that are free of domesticated animals. (Penrod-East Central)

**2503 - D4, E3, F1 500**

### THE RECYCLING OF ORGANIC WASTE: INTENSIVE CATTLE PRODUCTION,

Asia Research Pte. Ltd.

Asia Research Pte. Ltd., Stamford House, Stamford Road, Singapore 6, 1974. 36 p. 40 fig, 24 tab, 62 ref.

Descriptors: Recycling, Organic wastes, Technolo-

gy, Fermentation, Cattle, Poultry, Costs, Feedlots
Identifiers: Refeeding, Microbial contamination

The recycling system is bound to be widely adopted in order for the cattle industry to meet future pollution control and food shortage problems. Technology for recycling animal wastes for beef cattle consumption has been developed by Dr. Z. Muller of Asia Research (Pte.) Ltd. The technology is based on lactic fermentation which converts organic waste (including animal waste, industrial and agricultural by-products and municipal garbage) into inexpensive but highly efficient animal feed. The fermentation process has eliminated the problem of microbial contamination and thus cancels the need for any costly drying of the organic waste. Dr. Muller emphasizes the intrinsic value of poultry litter as the most valuable source for conversion into cattle feed when compared to poultry manure, cattle litter, and feedlot waste. Advantages of organic waste recycling techniques are: (1) increased production of beef of a higher quality, (2) more economical beef production, (3) beef production, without arable or agricultural land, (4) the release of cereals and vegetable protein for human and monogastric consumption and (5) abatement of a pollution problem. Consultancy is offered by Asia Research (Pte.) Ltd. for those who may be interested in conversion of organic waste for a feedlot operation or those who wish to consider the processing of organic waste as a commercial feed ingredient. (Battles-East Central)

### 2504 - A1, B1, E1 400
### STRIP-MINE FEEDLOTS,
B. McElroy
The Furrow, Vol. 78, p. 15, April, 1973. 1 fig.

Descriptors: Strip mines, Feedlots, Cattle, Performance, Runoff, Ohio.
Identifiers: Waste management.

Ohio State University has found an abandoned strip mine to be a practical feedlot for cattle. An initial cost of $125 was required to build a barbed-wire fence around a couple of acres of abandoned strip pit and to pipe water to the lot from a pond in a field above the pit. Many benefits were found to be gained by this sort of an arrangement. The first group of steers tested in the lot actually gained more efficiently than another group fed in a total-confinement unit. Even though the animals in the strip-mine feedlot didn't have shelter, they were not stressed by bad weather because the vertical high wall left by the mining operation made an excellent weather break. Manure removal was not found to be necessary. The steers trampled their manure down into the stony subsoil. Soil conservation experts say that this action will eventually leach the mine acids out of the soil and permit grass to grow. Evaluation of a bigger strip-mine lot was similar, with average daily gain of the steers being better than two pounds per head. The study concludes that now the scars left by strip-mining can be put to good use and at the same time make the cattle business a little better than the sometimes-marginal business it is. (Penrod-East Central)

### 2505 - A1, B1 100
### THE MICROFLORA OF POULTRY HOUSE LITTER AND DROPPINGS,
Department of Poultry Husbandry, Ohio State University, Columbus
E. R. Halbrook, A. R. Winter, and T. S. Sutton
Poultry Science, Vol. 30, p. 381-388, 1951. 5 fig, 9 ref.

Descriptors: Bacteria, Molds, Yeasts, Litter, Analyses, pH, Lime, Temperature
Identifiers: Microflora, Vitamin B-12, Corn cobs, Shavings, Bark.

Tests conducted concerning the relationship of litter management to the vitamin $B_{12}$ requirements of growing chicks instigated a study of the microflora of the litter and droppings of these test chicks to determine the possible relationships to vitamin $B_{12}$ content. The litter that was analyzed was used by chicks during the first 8 weeks of brooding. Results are presented for the microflora analyses of 86 litter samples and 60 droppings samples. The litter varied from unused litter to litter which had been used more than a year. Corn cob litter was predominantly studied, but shavings and bark were also analyzed. Bacteria, molds, and yeasts showed definite increase in poultry which had aged up to at least 6 weeks. Built-up litter (over 1 year old) contained fewer yeasts, molds and coliforms than either weekly changed of unchanged litter (1-8 weeks of use) and fewer lactobacilli and enterococci than unchanged litter. Liming built-up litter at a rate of 10-15 lbs. per 100 sq. ft. of floor space as needed for conditioning the litter reduced noticeably all classes of bacteria, yeasts, and molds. Feed and water appeared to be major factors affecting the microflora of the intestinal tract of chickens. The total count for both aerobes and anaerobes plus aerobes was highest at 30 degrees C storage, corresponding to the higher vitamin $B_{12}$ content reported at this temperature. The pH of poultry litter increased from 6.3 for new cob litter to 7.0 for unchanged litter after 1-8 weeks for use, and 8.0 for built-up litter. Limed built-up shavings litter showed a pH of 8.6 as compared to 7.5 for unlimed litter. The change in pH of litter as it ages probably explains the decrease in yeasts and molds present. (Penrod-East Central)

### 2506 - A1, B1 200
### AGRICULTURE AND NATURE'S NUTRIENT CYCLES,
The Fertilizer Institute, Washington, D. C.
W. H. Garman
In "Relationship of Agriculture to Soil and Water Pollution," Cornell University Conference on Agricultural Waste Management, Rochester, New York, 1970, p. 11-20. 2 tab, 12 ref.

Descriptors: Agriculture, Water pollution, Nitrogen fixation, Photosynthesis, Eutrophication, Ammonia, Feedlots.
Identifiers: Nutrient cycles, Nitrogen oxides.

Photosynthesis and nitrogen fixation are the two most important processes going on today in nature. Animal life would soon disappear without them, even though neither is characteristic of the animal kingdom. The objective of this report is to determine the effect agriculture has on nature's nutrient cycles. One way that agriculture affects the nutrient cycles is its possible contribution to the pollution of streams and rivers. Because of the large number of variables involved and some unknown factors, it is much more difficult to determine the contribution of farms than a city or factory to the pollution load of a stream. There is a considerably larger amount of nitrogen in such forms as nitrogen oxides and ammonia that occur in the rain, near livestock feedlots, cities, and certain types of industrial plants. Nitrogen oxides going into the atmosphere in the USA from automobile exhausts alone, and being returned to land, probably exceed two million tons of nitrogen a year. Too often these natural and artificial atmospheric inputs are almost completely overlooked and may end up being assigned to the agricultural sector. Agriculturalists now realize that to determine agriculture's exact contribution to pollution, sufficient information is lacking. Several years of tedious work in numerous water sheds by skilled individuals is required to obtain this information. Regarding the agricultural sector, agronomists have compared major streams in non-agricultural regions with similar ones in various agricultural regions which they have studied. This comparison will probably show us that agricultural land adds no more nutrients to water than does nature herself. (Penrod-East Central)

### 2507 - A3, A5, E2 300
### MANAGE MANURE FOR ITS VALUE,
College of Agricultural and Life Sciences, Wisconsin University, Madison
L. M. Walsh, R. F. Hensler and E. E. Schulte
Circular A1672, Wisconsin Agricultural Extension Service, Madison, May, 1975, 6 p. 5 fig, 3 tab.

Descriptors: Solid wastes, Liquid wastes, Crop response, Odor, Lagoons, Agricultural runoff, Leaching.
Identifiers: Nutrient conservation, Land disposal, Volatilization.

Although manure is a valuable by-product of the livestock industry, only a fraction of its potential crop-producing value is realized. Some of the reasons are: poor distribution when applied, runoff losses, leaching, and volatilization. The purpose of this report is to discuss the fertilizing value of manure, the quantity and composition of manure produced by Wisconsin livestock, and the methods of conserving and handling manure. Manure adds nitrogen, phosphorus, organic matter, potassium and other elements such as magnesium, boron, copper, calcium, sulfur, manganese and zinc to the soil. Factors affecting manure composition are the kind and amount of litter, the kind of animal, digestibility of the feed consumed, and handling and storage procedures. The distribution of nutrients in liquid and solid manure is discussed. Of the crops which can utilize nitrogen and other nutrients from the manure, corn responds best. Several methods of conserving nutrients are: (1) reduce liquid losses, (2) consider chemical preservatives, and (3) reduce volatilization losses. Methods for solid manure handling that are discussed are: (1) daily-spread manure, (2) stacked manure, and (3) loose housing manure. Liquid systems of manure handling include: (1) aerobic lagoons, and (2) anaerobic lagoons. Chlorine and hydrated lime are important chemicals in the control of odor. (Penrod-East Central)

### 2508 - A2, A5, B1, D1, E2, E3 400
### EMERGING ISSUES IN FEEDLOT WASTE MANAGEMENT,
J. M. Sweeten
Feedlot Management, Vol. 17, No. 5, p 16, 18, 23, 26, May, 1975.

Descriptors: Feedlots, Agricultural runoff, Odor, Recycling.
Identifiers: Waste management, Application rates, Refeeding, Sediment management.

This report discusses areas of needed improvement that are emerging in feedlot waste management. Since many feedlots have invested from $.50 to $7.00 per head of capacity for runoff control systems, care needs to be taken to protect these investments. One common problem is failure to dewater the retention structures within a prescribed time period following a major storm. Another problem is the proper determination of the right runoff application rates on crop or pasture land. Sediment management in retention ponds must also be dealt with. Possible solutions for these problems are projected. The quality of manure used in crop disposal has recently become a pressing issue. Attempts are being made to improve manure quality through better handling techniques. Animal wastes have been found to have value when recycled as gas or as feeds, but there are still problems to be worked out. Although all of the above are important aspects of feedlot management, the area with the greatest need of research is odor control. Because of the legal aspects of the odor problem, there is a great need for more research on odor measurement, odor control techniques, and prediction of odor transport phenomena. (Penrod-East Central)

### 2509 - A5, A9, E3 100
### DEHYDRATED POULTRY WASTE IN POULTRY RATIONS,

Department of Poultry Science, The University of British Columbia, Vancouver 8, British Columbia, Canada
J. Biely, R. Soong, L. Seier and W. H. Pope
Poultry Science, Vol. 51, p. 1502-1511, 1972. 15 tab, 10 ref.

Descriptors: Performance, Health, Economics, Odor
Identifiers: Dehydrated poultry waste, Rations

Dehydrated poultry waste, with less than ten per cent moisture content, was fed at levels of five to thirty percent to chicks, broiler stock, and laying hens in rations calculated to be approximately isonitrogenous (total N) and isocaloric. When the DPW was included in a well-balanced ration, no detrimental effect was observed on the health of the birds. Growth and feed efficiency decreased when the DPW content was increased beyond ten per cent. The economics of the over-all operation will require much study. "Even if the poultry industry had to subsidize the production of DPW to make it competitive with other ingredients, it would be justified, since it would allow the poultry men to stay in business with fairly odor-free premises and at the same time contribute to the improvement of the 'quality' of the environment." (Whetstone, Parker, and Wells-Texas Tech University)

**2510 - E3** **400**

### SECOND THOUGHTS ABOUT RECYCLING POULTRY WASTES,

Cornell University
M. L. Scott
Egg Industry, Vol. 5, p. 52, 54, May, 1972. 3 tab, 1 ref.

Descriptors: Recycling, Poultry, Phosphorus, Economics
Identifiers: Refeeding.

Dried poultry waste has a low energy content. When used in a poultry ration its value is primarily for phosphorus. Viewed as a manure disposal method it may be uneconomical since only a decreasing percentage of the total manure produced can be refed to the same flock. (Whetstone, Parker, and Wells-Texas Tech University)

**2511 - B1, F1** **400**

### SHOULD SUPERPHOSPHATE BE USED ON MANURE?,

Poultry Digest, Vol. 31, p. 42, 1972.

Descriptors: Poultry, Drying, Fertilizers, Economics.
Identifiers: Superphosphate.

Superphosphate has been used on manure accumulations below cages as a water absorbent for some years. After a four- to six-inch layer accumulates, natural drying renders the superphosphate relatively ineffective. Since superphosphate is frequently used as fertilizer, however, it becomes a question of the economics of adding it before or after field spreading. (Whetsone, Parker, and Wells-Texas Tech University)

**2512 - A9, D2, E3** **400**

### INFLUENCE OF FEEDING DEHYDRATED POULTRY WASTE ON BROILER GROWTH, AND MEAT FLAVOR, AND COMPOSITION,

Dairy and Poultry Science Department, Kansas State University, Manhattan
F. E. Cunningham and G. A. Lillich
Poultry Science, Vol. 54, No. 3, p. 860-865, May, 1975. 4 tab, 23 ref.

Descriptors: Performance, Feeds, Taste
Identifiers: Refeeding, Dried poultry wastes

Three levels (9.6, 19.1, and 38.2 per cent) of dehydrated poultry waste were fed to broilers to determine (1) the resulting flavor of the flesh, (2) growth and feed efficiency, and (3) certain parameters of carcass composition and quality. Flavor differences were studied by use of the triangle taste test. Panel members were unable to detect flavor differences between the 0 per cent and the 38.2 per cent DPW treatments. Dark meat was analyzed for protein, ether extract, calcium, phosphorus and TBA value. No significant differences were found between the DPW fed meat and the control meat. Poultry fed 38.2 per cent DPW had the poorest performance, as evidenced by lower average live weight, lower average eviscerated weight, and poorer feed conversion. It was determined that dried poultry waste may be fed to broilers at a level below 20 per cent without serious consequences. (Penrod-East Central)

**2513 - A5, D1** **100**

### THAT ODOR!,

A. T. Sobel
Compost Science, Vol. 7, p. 19-21, Spring-Summer, 1966. 3 fig, 9 ref.

Descriptors: Odor, Control, Ventilation, Absorption, Adsorption, Chemical reaction
Identifiers: Detection, Combustion, Masking, Counteraction.

Odor is defined as a substance that has the property of affecting the sense of smell. Since smell means the perceiving of a substance by the excitation of the olfactory nerves, the author states that odor cannot exist if people are not present to detect it. There are two general categories of odors—source odors and ambient odors. Source odors are defined as odors at the point of origin. Ambient odors are those that are distributed in the atmosphere. Several odor characteristics are important in considering the source, detection, and control of these odors. They are quality, strength, and occurrence. Each of these are defined and the feasibility of using each in odor detection is examined. Odor control is discussed from the viewpoint of eliminating either the source or the odor itself. The methods used to control gaseous odor are ventilation, combustion, absorption, adsorption, masking, counteraction and chemical reaction. Odor control depends on the nature of the odor, good housekeeping, and a working management program. The study concluded that source elimination is a more realistic approach than odor elimination. (Penrod-East Central)

**2514 - A5, B1, E2** **100**

### DAIRY WASTE MANAGEMENT SYSTEMS,

Department of Agricultural Engineering, University of Minnesota, St. Paul
D. W. Bates
Journal of Dairy Science, Vol. 56, No. 4, p. 495-499, April, 1973. 6 ref.

Descriptors: Dairy industry, Minnesota, Confinement pens, Waste storage, Waste disposal, Odor, Ventilation.
Identifiers: Housing, Stall barns, Free stall barns, Land disposal.

Waste handling systems may range from a gutter cleaner and daily hauling with a manure spreader to extended storage in concrete tanks whose contents are pumped and spread periodically. Two general classes of dairy housing in Minnesota, conventional stall barn and free-stall barn, are discussed in relation to manure handling. Free-stall barns can be either cold (open, uninsulated buildings where natural air movement provides ventilation and the barn temperature approximates the outside temperature) or warm (completely insulated and mechanically ventilated). The cost variation between the two free-stall systems stems from the manure handling system and the housing structure. Manure storage capacity is usually limited to a few months because of the cost. How the manure is to be disposed of or utilized is essential in deciding on how much storage should be provided. The effects of cold weather, deep snow, soft fields in the spring, and fields planted to crops must be considered. Stall barns with grated gutters or free-stall barns with slatted floors, both with under-the-building manure storage, offer a suitable system with minimum labor. Ventilation systems of high capacity must be provided for all confined units. Waste heat from the dairy barn ventilation system will prevent freezing. (Penrod-East Central)

**2515 - A1, E2** **100**

### PHYSICAL AND CHEMICAL PROPERTIES OF SOIL ASSOCIATED WITH HEAVY APPLICATIONS OF MANURE FROM CATTLE FEEDLOTS,

Nebraska Agricultural Experiment Station
A. E. Tiarks, A. P. Mazurak, and L. Chesnin
Soil Science Society of America Proceedings, Vol. 38, p. 826-830, 1974. 5 fig, 3 tab, 18 ref.

Descriptors: Physical properties, Chemical properties, Soils, Feedlots, Cattle, Hydraulic conductivity, Electrical conductance
Identifiers: Land disposal, Organic carbon, Particle density, Modulus of rupture

The objectivies of this study were: (1) to determine the effects of heavy manure applications on the physical properties of soil; (2) to determine the amount of manure, if any, that would deteriorate these physical properties; and (3) to determine the effects of the tillage depth in mixing manure into the soil. Cattle feedlot manure was applied to Sharpsburg silty clay loam at 0, 90, 180, and 360 metric tons ha$^{-1}$ year$^{-1}$ at depths of 10, 20, and 30 cm. At 10 cm depths, the heaviest applications increased soil organic carbon 2-5 per cent after 2 years. It was found that organic carbon content increased linearly with increasing amounts of manure. Increasing the tillage depth resulted in smaller increase in the organic carbon content of the soil. Particle density decreased linearly as a result of higher amounts of organic matter in the soil. Increasing application of manure significantly reduced bulk density. Heavy application of manure increased the geometric mean diameter (GMD) of water-stable aggregates in the surface 10 cm. of the soil. Modulus of rupture decreased with increasing amounts of manure because the increase in organic matter allowed less cohesion of soil particles. Hydraulic conductivity of the soils was extremely variable. Hydraulic conductivity of undisturbed soil cores increased five fold. However, manure applications reduced the hydraulic conductivity of disturbed soils sampled in the fall; there was no effect on spring samples. The heaviest application of manure increased the electrical conductivity of the hydraulic conductivity leachates in both the fall samples and the spring samples. Manure application had decreased effects on soil properties with increased depth of tillage. (Penrod-East Central)

**2516 - A2, A3, A5, B1, E2** **300**

### IMPACTS OF IMPOSING SELECTED POLLUTION CONTROLS,

Department of Agricultural Economics, Cooperative Extension Service, Michigan State University, East Lansing
D. Good, L. J. Connor, J. B. Johnson, and C. R. Hoglund
Michigan Farm Economics Report No. 360, Cooperative Extension Service, Michigan State University, East Lansing, January, 1973, 4 p. 2 tab.

Descriptors: Michigan, Dairy industry, Legal aspects, Costs, Agricultural runoff, Odor, Waste storage.

Identifiers: Pollution control, Land disposal, Subsurface disposal.

Three selected pollution control measures are analyzed which might conceivably be applied to Michigan dairy farms. The measures are based on recent actions taken by the Michigan Water Resources Commission and Air Pollution Control Division and on statutes relative to dairy waste management that have been enacted or proposed in adjoining states. The first control measure requires control of surface water runoff at the production site. The second measure, designed to control runoff from fields to which wastes are applied, prohibits winter spreading of dairy wastes. The last measure, designed to reduce odors and field runoff associated with land application of dairy wastes, requires immediate plow-down of solid dairy wastes and-or soil injection of liquid dairy wastes. Twelve "representative" farms were chosen for the study. Adjustments necessary to comply with the control measures were identified. These control measures will cause increased cost of operation which will inevitably be passed on to the consumer. Projections of increased costs are given. (Penrod-East Central)

**2517 - A4, B1 300**

### POLLUTED GROUNDWATER: ESTIMATING THE EFFECTS OF MAN'S ACTIVITIES,

General Electric-TEMPO, Center for Advanced Studies, P. O. Drawer QQ, Santa Barbara, California
J. F. Karubian
EPA Report No. 6804-74-002, July, 1974, 99 p. 6 fig, 36 tab. 29 ref.

Descriptors: Feedlots, Industrial wastes, Fertilizers, Methodology.
Identifiers: Groundwater pollution.

This report presents a method for estimating kinds, amounts, and trends of groundwater pollution caused by man's activities. It describes preliminary research for a number of examples: unlined earthen basins and lagoons used by the pulp and paper industry, petroleum refining, and primary metals industries; phosphate mining wastewater ponds; agricultural fertilizer use; and beef cattle feedlots. It was compiled by use of census data, other statistical data, and descriptions of production processes used. Past and projected volumes and areas covered by potential pollutants are estimated so that geohydrological analysis can be used to estimate the infiltration potential of pollutants. Results are not definitive but intend only to illustrate use of the methodology for geographical areas of interest. (W. E. Rogers--TEMPO)

**2518 - C3 100**

### DISTRIBUTION OF THE MAJOR NITROGENOUS COMPOUNDS AND AMINO ACIDS IN CHICKEN URINE,

Departments of Agricultural Chemistry and Poultry Husbandry, Missouri University, Columbia
B. L. O'Dell, W. D. Woods, O. A. Laerdal, A. M. Jeffay, and J. E. Savage
Poultry Science, Vol. 39, p. 426-432, 1960. 1 fig, 3 tab, 17 ref.

Descriptors: Nitrogen compounds, Urine, Poultry, Amino acids, Ammonia.
Identifiers: Creatine, Uric Acid, Arginine.

Urine from male White Leghorn chicks, 5-6 weeks of age, was analyzed for uric acid, ammonia, urea, creatine and creatinine, and amino acids. Diets fed to these chicks were either (1) a corn-soya diet or (2) purified diets containing as the source of protein, casein, casein and gelatin, casein and supplemental arginine, and liver protein. Uric acid constituted about 81 per cent of the total nitrogen and ammonia about 10 per cent. Amino acid nitrogen made up approximately 2 per cent of the total urinary nitrogen. The proportion of urea increased with the addition of free arginine to the diet, but the creatine-creatinine nitrogen and the distribution of amino acids were unaffected by the diet. (Penrod-East Central)

**2519 - A1, B1, F2 400**

### KEEPING THE FEEDER IN BUSINESS,

Soil Conservation Service, Lincoln, Nebraska
L. G. Jackson
Soil Conservation, Vol. 39, No. 2, p. 10-11, September, 1973. 3 fig.

Descriptors: Nebraska, Feedlots, Regulation, Water pollution, Design.
Identifiers: Soil Conservation Service.

The 17,000 feedlots in Nebraska cause a great many waste management problems. The Soil Conservation service engineered a system to prevent runoff at the request of a 1000-head Adams County feedlot. A bypass system was devised that involved keeping a farm pond from discharging into the feedlot. A debris basin and holding pond were then designed that would control a 10-year, 24 hour storm that could cause runoff from the lot. The lot was sold before the system was implemented, and the new owners doubled the feedlot capacity, making it necessary for a new debris basin to be installed. The farm pond was changed to a tailwater recovery pit to which all liquid waste was carried. A pipeline was installed to carry liquid waste to the high point in the disposal area for distribution to the croplands by irrigation. Costs of the system were $3700. At the time of this publication, about 650 waste control systems had been installed on Nebraska feedlots, and more were in the design stage. All these feedlots are carefully inspected by the Department of Environmental Control in order to assure that owners do not violate water quality standards. (Sanders-East Central)

**2520 - A8, A9, B1, D3 100**

### POLYVINYL CHLORIDE-INSECTICIDE PELLETS FED TO CATTLE TO CONTROL FACE FLY LARVAE IN MANURE,

Entomology Section, Wyoming University, Laramie
J. E. Lloyd, and J. G. Matthysse
Journal of Economic Entomology, Vol. 63, p. 1271-1281, August, 1970. 2 fig, 7 tab, 28 ref.

Descriptors: Insecticides, Cattle, Toxicity.
Identifiers: Fly control, Feed additives, Larval Mortality, Manure.

The objective of this study was to determine the effects of feeding PVC-insecticide pellets to cattle for the control of face fly larvae and pupae. Determinations were made of larval and pupal mortality as a result of insecticide dosage, polymer pellet size and the concentration of insecticide in the polymer. The length of time that toxic manure was passed after feeding was discontinued, was also studied. Of the systems tested, PVC-diazinon and PVC-dichlorvos were the most promising feed additive larvicides. Larval control was unexpectedly poor in most of the manure samples from cows fed Product V-13 at 0.25 mg dichlorvos kg per day. When XP-515 dosage was increased to 0.5 mg kg per day, larval mortality was complete in all except one of the field-collected manure patties. Smaller fly populations in the barn of the insecticide treated herd indicated that the feed additive may have had some effect in reducing the numbers of these flies. Treated cows showed no symptoms of toxicity. No indication of inhibition of cholinesterase activity in whole blood of cattle was noted when they were fed Shell formula XP-515 at 0.25 and 0.5 mg kg per day. There was no detectable dichlorvos residue in the milk of these cows. (Penrod-East Central)

**2521 - A1, E2 100**

### SOME EFFECTS OF FERTILIZERS AND FARMYARD MANURE ON THE ORGANIC PHOSPHORUS IN SOILS,

Rothamsted Experimental Station, Harpenden, Herts
O. G. Oniani, M. Chater, and G. E. G. Mattingly
Journal of Soil Science, Vol. 24, No. 1, p. 1-9, 1973. 6 tab, 41 ref.

Descriptors: Soils, Fertilizers, Environmental effects, Carbon, Nitrogen, pH.
Identifiers: Manure, Organic phosphorus.

This report describes the effects of phosphate fertilizers alone, or with farmyard manure, on the total carbon, nitrogen, and organic phosphorus contents of a range of acid and neutral soils of known history. Organic phosphorus estimated by extraction was less than that estimated by ignition except in soils from Ceylon. Differences in the organic phosphorus estimated by the two methods appeared to increase with the per cent of carbon in the soils. Organic phosphorus amounts averaged 120 ugP/g less by ignition than by extraction in the 3 acid soils from Ceylon which contained the most dithionite-soluble iron. The carbon and nitrogen contents of the Barnfield soils was almost trebled by farmyard manure while the carbon-nitrogen ratios only slightly increased. Little organic phosphorus was accumulated in these soils and the carbon-organic phosphorus ratios were about 100 with farmyard manure, 100 with superphosphate, and 72 without phosphate. In Park Grass soils, nitrogen-organic phosphorus and carbon-nitrogen ratios were 9.7 to 15.7 and 11.5 to 13.0, respectively in the surface layer and 8.5 to 15.4 and 10.3 to 11.0 in the sub-surface soil. The carbon content of Barnfield soils (0-23 cm) was approximately trebled when farmyard manure was applied for 100 years; whereas, organic phosphorus increased on average by one-third. The surface soils of Park Grass had about 6 per cent of the phosphorus remaining from superphosphate accumulated as organic phosphorus at pH 4.5 and only 1 per cent at pH 6.2-6.5. The inositol phosphate contents ($iP_5$-$iP_6$) of the Rothamsted soils and Georgia soils ranged from 17 to 45 per cent of the total organic phosphorus by extraction. The proportions of inositol phosphates in these soils which were least (17 to 22 per cent) in the surface soils from Park Grass were not significantly changed by either farmyard manure or superphosphate. (Penrod-East Central)

**2522 - A1, C3, E2 300**

### THE USE AND VALUE OF ANIMAL WASTE AS FERTILIZER FOR CROP PRODUCTION,

Extension Agronomist, Oklahoma State University, Stillwater
B. B. Tucker, C. H. Burton, and J. M. Baker
Circular E-815, Oklahoma State University Extension, Stillwater, March, 1972, 6 p. 6 tab.

Descriptors: Animal wastes, Fertilizers, Crop response, Nutrients, Cattle, Poultry, Feedlots.
Identifiers: Swine.

Because animal wastes contain certain elements needed for high levels of crop production, the most feasible procedure for disposing of them is by spreading on crop land. There are certain problems, however, associated with this disposal method. The most obvious problems are: (1) the wastes are low analyses, (2) all the nutrients in manure are not always needed for crop production, (3) the application of manure rarely eliminates the need for supplemental fertilizer use, and (4) too much manure can cause burning. Frequent soil tests to monitor the soil chemical constituents are especially desirable whenever manure is being applied to land. Also, soil tests prior to application can serve as a useful guide in ascertaining amounts of fertilizer needed to supplement the manure. This study was undertaken to give a clearer understanding of animal manure value. (Cameron-East Central)

**2523 - A2, A4, B2, D4, E2** 300

### FEEDLOT WASTE DISPOSAL AND WATER POLLUTION,

Extension Agricultural Engineer, Colorado State University, Fort Collins
R. Hansen
Publication AE70-71RWH1, Colorado State University Livestock Days, January, 1971, 5 p. 1 tab.

Descriptors: Feedlots, Agricultural runoff, Water pollution, Lagoons, Settling basins
Identifiers: Land disposal, Detention ponds, Settling channels.

The principle sources of pollution from feedlot wastes are organic substances, volatile substances, inorganic substances, pathogens, and insects harbored by the waste material. While the constituents of manure are especially a problem if allowed to reach bodies of water, the nutrient content of manure makes it a valuable fertilizer material. One of the major pollution problems of feedlot wastes is agricultural runoff. Studies have indicated that the runoff water can be collected and disposed of by several methods. Options include retention ponds, lagoons, settling basins, settling channels, and land disposal. Biological treatment systems can be used, but it is difficult to operate them satisfactorily with the intermittent flows usually encountered in runoff collection systems. Although the likelihood of groundwater pollution from feedlots seems small, there really is very little information available on this subject. (Penrod-East Central)

**2524 - A1, B1, F2** 500

### POLLUTION—CONTROL TECHNIQUES AND REQUIREMENTS,

A. J. Muehling and D. L. Day
Vertical Coordination in the Pork Industry: Proceedings, AVI Publishing Company, Inc., Westport, Connecticut, 1971, p. 127-138. 4 fig, 7 ref.

Descriptors: Regulation, Illinois, Agricultural runoff, Odor, Permits.
Identifiers: Pollution control, Swine, Waste handling, Guidelines.

The main objectives of this report are: (1) examine the regulations governing pork producers in Illinois; (2) provide guidelines for producers to use in planning swine installations; and (3) discuss systems for handling swine manure. In order to carry out the objectives of the 1970 Illinois Environmental Protection Act, three agencies were created: the Pollution Control board, the Environmental Protection Agency, and the Institute for Environmental Quality. These agencies and their functions are briefly discussed. Possible regulations governing registration, runoff, odor, handling and disposal of swine wastes are examined. Suggestions for pork producer guidelines are: (1) plan an approved method of swine waste handling; (2) consider odor nuisances in locating the facility; (3) control runoff and manure overflow; (4) be considerate of neighbors; and (5) practice good housekeeping. Systems for handling swine manure including simple, complex and combined systems are examined. They include: (1) solid floors—scrape floors and haul; (2) slotted floors—store and haul; (3) slotted floors—lagooning and hauling; (4) slotted floor—oxidation ditch with lagoon; and (5) flushing gutter—lagoon and irrigation. Future waste management possibilities are given which have the common objective of utilizing wastes, instead of creating a disposal problem. Pollution control regulations should result in a concern for uniformity in the regulations, stronger pork producers' organizations, and cooperation with agencies on regulations governing pork installations. (Penrod-East Central)

**2525 - B2, D3** 100

### PHOSPHATE REMOVAL FROM DUCK FARM WASTES,

Cornell University, Ithaca, New York
R. C. Loehr and K. J. Johanson
Journal Water Pollution Control Federation, Vol. 46, No. 7, p. 1692-1714, July, 1974. 10 fig, 7 tab, 6 ref.

Descriptors: Waste water (pollution), Waste water treatment, Ducks (domestic), Lagoons, Lime, Costs.
Identifiers: Phosphate removal, Alum, Ferric chloride, Orthophosphate.

The importance of phosphorus in eutrophication is widely recognized, and high phosphate removals are being required before wastewaters are discharged to surface waters. This report examines the results of detailed studies of phosphate removal from wastewaters from the production of ducks for slaughter. These tests were conducted over a two-year period. In the 1970 study, alum, lime, and ferric chloride were evaluated as capable of achieving high orthophosphate removals and low residual orthophosphate concentrations. Higher chemical quantities were required for the processing wastewaters to accomplish a specific removal than did the duck farm wastewaters. Lime, followed by alum and ferric chloride, was found to be the least-cost chemical involved in phosphate removal. The study showed the economic advantage of matching chemical dosage to wastewater characteristics to obtain a specific orthophosphate removal. The 1971 study showed the orthophosphate concentration in both untreated duck wastewater and aerated lagoon effluent varied considerably throughout the production season. The highest concentrations were in the summer and early fall. The experiment showed that phosphate control equipment should be added between the aerated lagoon and the settling lagoons whenever it is used. Based on Tuttle farm results, phosphate removal increased the operating cost of the existing waste treatment facilities from $0.022 to $0.032-season-bird marketed over a phosphate removal range of 50 to 90 per cent. It was also found that the addition of chemicals increased the amount of sludge to be disposed of, probably doubling the sludge disposal problem. (Penrod-East Central)

**2526 - E3** 300

### COMPOSITION AND DIGESTIBILITY OF CATTLE FECAL WASTE,

D. M. Lucas, J. P. Fontenot and K. E. Webb, Jr.
1973-74 Livestock Research Report, Research Division Report 158, Virginia Polytechnic Institute and State University, Blackburg, July, 1974, p. 110-118.6 tab.

Descriptors: Cattle, Chemical properties, Physical properties.
Identifiers: Refeeding, Digestibility, Dried steer feces.

An experiment was conducted to evaluate the composition and digestibility of cattle manure produced by steers fed a ration containing approximately 50 per cent roughage. Three metabolism trials were conducted using six yearly steers. The composition of the dried steer feces fed was approximately 38.8 per cent NFE, 13.2 per cent crude protein and 71 per cent cell walls, dry basis. Low digestibilities were noted for components of dried steer feces—16.6 per cent for dry matter, 26 per cent for crude protein and 16 per cent for energy. The study showed that dried feces from steers fed a 50 per cent roughage ration has little value for refeeding to steers. Tables are provided showing the composition of the rations for each trial, the chemical composition of dried steer feces, the apparent digestibility and TDN and Metabolizable energy content of basal and feces containing rations, the apparent digestibility and TDN and metabolizable energy content of dried steer feces, and the utilization of nitrogen in basal and dried steer feces containing rations. (Penrod-East Central)

**2527 - A9, D4, E3** 300

### FERMENTATION OF ENSILED BROILER LITTER,

L. F. Caswell, J. P. Fontenot and K. E. Webb, Jr.
1973-74 Livestock Research Report, Research Division Report 158, Virginia Polytechnic Institute and State University, Blacksburg, July, 1974, p. 100-109.

Descriptors: Fermentation, Litter, Pathogens, Drying, Nutrients.
Identifiers: Ensiling, Broilers, Drugs, Refeeding.

The possible presence of medicinal drugs and pathogenic organisms is the main problem confronting the approval of broiler litter for use as a livestock feed. Ensiling litter as it comes from the broiler house or following water addition may make it a more desirable product for several reasons; among them reduction of drugs and pathogens. The purpose of this study was to determine the level of moisture necessary for optimum fermentation of ensiled broiler litter and to evaluate the effect of ensiling on bacterial content. The general purpose of the study was to determine the feasibility of ensiling broiler litter alone in an attempt to obtain guidelines for similar ensiling studies on a larger scale. Study results indicated that broiler litter will sustain fermentation when ensiled if water is added. The moisture level of litter must be increased to at least 30 per cent to initiate active fermentation. The nutrient content of the litter was not harmed by ensiling. Enteric bacteria were destroyed through ensiling, thus rendering the material free of pathogens capable of inducing intestinal or urogenital tract disorders. However, the total bacteria counts of fermented litter may not be as low as desired. (Penrod-East Central)

**2528 - A4, B2** 300

### POLLUTANT MOVEMENT TO GROUND WATER FROM SWINE WASTE LAGOONS,

Department of Agronomy, Virginia Polytechnic Institute and State University, Blacksburg
T. G. Ciravolo, K. L. Hallock, H. R. Thomas, E. R. Collins, Jr., D. C. Martens and E. T. Kornegay
1973-74 Livestock Research Report, Research Division Report 158, Virginia Polytechnic Institute and State University, Blacksburg, July, 1974, p. 5-10. 4 tab.

Descriptors: Groundwater pollution, Lagoons, Anaerobic conditions, Coliforms, Nutrients.
Identifiers: Swine.

Flushing swine wastes into an anaerobic lagoon is a relatively inexpensive waste disposal method. Information from a literature search indicates that there may be seepage from such a lagoon. The purpose of this study is to monitor the effect of seepage from anaerobic swine lagoons on ground water quality. The two lagoons studied are located in high water table soils in the Coastal Plain Region of Virginia at the Tidewater Research and Continuing Education Center and at the Virginia Swine Evaluation Station. The wells, consisting of 2 inch PVC pipe, were water jetted at distances of 10, 50 and 100 ft. from the two anaerobic swine lagoons to depths of 10, 15, and 20 ft. At the 20 ft. depth that was 50 ft. from the lagoon at the Swine Evaluation Station in August and at the 10 ft. depth located 50 ft. from the lagoon in November, the 0.1 ppm Cu recommended limit was exceeded. Chemical-oxygen-demand, coliform bacteria, and concentration of $Cl^-$, $NO_3^-$, $NH_4^+$, soluble phosphate, Mg, K, Na, Cu, Zn, and Mn were the constituents being determined in ground water samples. Preliminary analyses summary shows that U. S. Public Health Department drinking water standards were not exceeded for $Cl^-$, $Cu^{++}$ $NO_3^-$ and $Zn^{++}$ Fluctuations in the chemical constituents concentrations indicated that ground water contamination occurred only at 10 ft. distances. A study is continuing with chemical oxygen demand and fecal coliform bacteria being determined. (Penrod-East Central)

**2529 - A9, B2, E3** 200

### POTENTIAL OF RECYCLING SWINE WASTE,

Illinois University
B. G. Harmon
Presented at Symposium on Utilization of Plant and Animal By-Products, University of Georgia, Athens, December 18, 1973, 10 p.2 fig, 11 tab, 17 ref.

Descriptors: Recycling, Performance, Illinois, Nitrates, Animal parasites.
Identifiers: Refeeding, Oxidation ditch, Swine.

The purpose of this report is to discuss experiments of the author and other researchers in the potential for recycling swine waste. In initial studies animal waste was simply collected, dried and mixed in the diet (Diggs et al., 1965). At Illinois, the recycling research has all been conducted with products of the oxidation ditch (Day et al., 1969). The initial studies are discussed by the author. In following studies, no attempt was made to isolate solids from the liquid of oxidation ditch mixed liquor (ODML), as it was considered as a source of water. In five replications a total of 76 finishing swine were fed twice each day in open troughs (Harmon et al., 1973a). Both gain and efficiency values were significantly greater for pigs receiving ODML even though the differences between treatments were small. The author advises that precautions are essential in the successful use of ODML since under certain conditions, nitrate increases to very high levels. The author also states that parasites must be rigidly controlled in the feeding program. In conclusion, Mr. Harmon says that recycled swine waste provides an available source of nutrients for swine. An oxidation ditch is a system which provides a source of nutrients while minimizing any potential for pollution. (Penrod-East Central)

### 2530 - A1, B1, F2 600

## REVIEW OF RESEARCH AND RECOMMENDATIONS ON ANIMAL WASTE MANAGEMENT CONTROL MEASURES FOR MONTANA WITH SPECIAL REFERENCE TO BEEF CATTLE FEEDLOTS,

Department of Agricultural Engineering, Montana State University, Bozeman
C. M. Milne
Special Report AE-101, Department of Agricultural Engineering, Montana State University, November 10, 1970, 36 p. 3 tab, 29 ref.

Descriptors: Montana, Feedlots, Cattle, Regulation.
Identifiers: Waste management, Pollution control, Guidelines

Definite steps are underway in Montana toward developing a State animal waste control policy. The purpose of this report is to provide guidance for the development of a suitable State policy and administrative mechanism for preventing pollution from livestock operations in Montana. In doing this, the author lists and describes four categories of potential pollution. They are: organic pollution, inorganic pollution, bacteriological pollution and esthetic pollution (nuisance). The major factors contributing to feedlot pollution potential are location, hydrology, feedlot concentration and feed supply. Waste management alternatives for both solid and liquid wastes are discussed. They include: biological stabilization, land disposal for crop growth, high rate land disposal, composting, vacuum filtration, trickling filters, etc. Five procedures are discussed on how to deal with feedlot runoff—(1) Uncontrolled release to a stream, (2) controlled release to a stream, (3) evaporation, (4) controlled release to land, and (5) biological treatment. The author believes, however, that returning the waste to the land for crop production is the most economically feasible system for Montana. A list of recommendations for regulations governing feedlots and a possible outline of feedlot design criteria are given. (Penrod-East Central)

### 2531 - A1, B1, E2 600

## GUIDELINES FOR CATTLE FEEDLOT DESIGN,

Department of Agricultural Engineering, Montana State University, Bozeman
C. M. Milne
Special Report AE-102, Presented at 1971 Montana Nutrition Conference, February 8-9, 1971, 18 p. 5 tab.

Descriptors: Feedlots, Design criteria, Montana, Engineering, Locating, Confinement pens.
Identifiers: Animal health, Unpaved lots, Paved lots, Runoff control, Waste management.

Montana already has the feed and cattle resources on which a feedlot industry can be based. The main objective of this study is to set engineering guidelines for establishment of feedlots. The general functional requirement for a feedlot is to produce a pound of beef at the lowest possible cost, subject to a possible quality constraint. The main materials handled in a feedlot are water, animal wastes, feed, and cattle. Feedlot functional requirements and criteria are related to the following factors: (1) Materials handling, (2) Utilization of equipment and labor, (3) Production and efficiency, (4) Animal health, and (5) Water and air pollution control. Design criteria are grouped into two categories: (1) Location and site requirements, and (2) Facilities design. Each category is individually discussed. The physical requirements of feedlot alternatives are given. Waste management alternatives for various production methods are discussed and a simplified table is also supplied. Housed feedlots have, in general, eliminated the "runoff" problem from the feedlot itself. A general procedure is outlined for the development of a major feedlot installation. (Penrod-East Central)

### 2532 - B2, D4, E3 700

## ALGAL GROWTH POTENTIAL OF SWINE WASTE,

Fulhage, C. D.
Unpublished Ph.D. Dissertation, University of Missouri, Columbia, May, 1973, 96 p. 24 fig, 2 tab, 37 ref.

Descriptors: Algae, Growth rates, Nutrients, Chemical analysis, Carbon, Nitrogen, Phosphorus, Chemical oxygen demand, Ammonia.
Identifiers: Swine, Oxidation ditch.

Research was undertaken to determine the amount of algae which can be grown from the nutrients contained in swine waste after it has undergone aerobic treatment such as that accomplished by an oxidation ditch. Under laboratory conditions, the primary algal nutrients carbon, nitrogen, and phosphorus were monitored along with pH, alkalinity, and chemical oxygen demand. It was concluded that aerobic oxidation is effective in converting organic carbon and nitrogen into inorganic forms available to algae. The loss of nitrogen as ammonia and carbon as carbon dioxide was evident during aeration. Because of this loss, these nutrients became unavailable to algae. In relation to algal growth requirements, phosphorus is by far the nutrient in excess in swine waste. This indicates that carbon and nitrogen must be supplemented to achieve phosphorus fixation. Swine waste offers an algal growth potential of about .2 grams of algae per gram of raw waste. (Cartmell-East Central)

### 2533 - A2, A5, A10, B2, E2 300

## DAIRY WASTE STORAGE PONDS FOR SOIL-PLANT RECYCLING,

Agricultural Extension, California University, Riverside
W. C. Fairbank, E. H. Olson, and G. A. Hutton, Jr.
University of California Agricultural Extension Publication No. AXT-n88, November, 1972, 6 p. 3 fig.

Descriptors: Dairy industry, Waste storage, Irrigation, Design, Liquid wastes, Storm runoff, Odor, Cleaning.
Identifiers: Land disposal, Pond management.

Along with the ultimate beneficial return to the land, waste storage ponds provide a system for collecting, settling, and storing liquified dairy manure and washwater for re-use in barn cleaning and manure transport. The things to consider when ascertaining the desirability of the liquid-waste ponding system are: how it relates to the cow confinement system, manure transport, work simplification, waste management, neighborhood acceptance and expected performance in all weather conditions. The ways in which the dairy waste storage ponds may meet the requirements for storm runoff control are outlined. Design of a waste management facility should be based on cost, safety and performance. The aspects of the liquid-waste ponding system that are examined are: (1) pond layout, (2) pond volume calculation, (3) pond depth, (4) levees and slopes, (5) pond sealing, (6) pipes, (7) pumps, and (8) fencing. Pond management includes the practice of emptying and flushing the ponds at each irrigation. Manure waste water should not exceed 30 per cent of the irrigation volume. The necessary equipment for such management is listed. Odor control and cleaning of the pond are also discussed. (Penrod-East Central)

### 2534 - B3, C3, D2, D3, E2, E3 100

## WHAT IS POULTRY MANURE WORTH?,

Associate Specialist in Poultry Husbandry, Hawaii University, Honolulu
S. McHenry
Compost Science, Vol. 2, No. 3, p. 13-15, Autumn, 1961.

Descriptors: Poultry, Fertilizers, Waste treatment, Recycling, Litters, Phosphate, Nitrogen, Lime, Odor, Nutrients.
Identifiers: Land disposal.

Besides being a good plant food, the organic matter in poultry manure has other important advantages. These include soil-conditioning effect, moisture-holding capacity, and resistance to leaching, which permits a gradual release of plant nutrients. Poultry manure must be treated and stored in order to preserve its nitrogen value. Phosphate is the most effective agent for achieving this. The rate of application should be at least 100 pounds of phosphate for each ton of fresh manure, or 5 per cent of the weight of fresh droppings (20 per cent of the dry weight of manure). Hydrated lime is the most effective deodorizer of poultry manure. Poultry manure removal methods are determined by size of operation, type of housing, and availability of labor. Manure removal methods range from a wheelbarrow and shovel to use of various mechanical cleaners that have been devised. Methods of disposing of poultry manure vary. The manure can be broadcast on the ground and plowed under before planting crops; it may be used in the potting mixture of many potted plants; it may be used on lawns or in flower beds; it may be dried, ground and packaged for farmers and home gardeners; or it may be processed for floor litter. (Penrod-East Central)

### 2535 - A9, E3 100

## FEEDING POTENTIAL OF RECLAIMED FECAL RESIDUE,

Animal Science Department, Auburn University, Auburn, Alabama
W. B. Anthony and R. Nix
Journal of Dairy Science, Vol. 45, p. 1538-1539, 1962. 2 tab, 1 ref.

Descriptors: Feeds, Cattle, Performance.
Identifiers: Refeeding.

Feces from full-fed cattle contain appreciable amounts of undigested feed residue. Not only does fecal grain represent an appreciable loss of feeding value but fecal matter creates a serious disposal problem. Research was done to (1) recover some of the fecal feed, and (2) develop an effective means of disposing of organic residues voided by confined cattle.

Cattle consumed a feed mixture containing washed wet fecal residue in amount equal to approximately 40 per cent by weight of the mixture. Cattle fed the fecal residue mixture gained over 3 lb daily and required less than 700 lb of dry matter per 100 lb of gain. For both dairy and beef herds, the relevance of this study is in the potential to derive more than manure value for undigested feed and microbial residues. (Cameron-East Central)

### 2536 - A9, C3, E3 100

### EFFECTS OF RECYCLING DRIED POULTRY WASTE ON YOUNG CHICKS,

Department of Animal Science, Iowa State University, Ames
N. Trakulchang and S. L. Balloun
Poultry Science, Vol. 54, No. 2, p. 615-618, March, 1975. 5 tab, 4 ref.

Descriptors: Diets, Poultry, Performance, Proteins.
Identifiers: Dried poultry wastes, Refeeding, Minerals.

An experiment was conducted to investigate the effects of refeeding dried poultry waste (DPW) in the diets of young chicks. Three experimental diets containing 0, 10, and 20 per cent recycled DPW were formulated isocaloric (2960 Kcal-kg) and equivalent in percentage of true protein (16 per cent), calcium, and phosphorus. The experiment was a randomized complete-block arrangement of treatments in a split-plot design, with numbers of recyclings as subplots. Feed and water were available to the chicks ad libitum throughout the 4-week test period. Weight gain of 4-8 week old birds was significantly depressed by diets containing 10 and 20 per cent DPW; however, feed efficiency was depressed by 20 per cent dietary DPW only. Calcium and magnesium contents of excreta decreased linearly as the number of recyclings increased, while potassium and zinc tended to increase and other minerals remained constant. Increasing DPW in the diet significantly decreased calcium, phosphorus, and iron in excreta and significantly increased sodium, potassium, copper, magnesium, manganese, and zinc. The results indicated that recycled DPW cannot be used successfully unless the calcium to phosphorus ratio (and content) of the diet is adjusted for each recycling. (Cameron-East Central)

### 2537 - A2, B2 600

### MODEL TO PREDICT THE PERFORMANCE OF FEEDLOT CONTROL FACILITIES AT SPECIFIC OREGON LOCATIONS,

Department of Agricultural Engineering, Oregon State University, Corvallis
R. B. Wensink and J. R. Miner
Presented at the 1975 Annual Meeting, American Society of Agricultural Engineers, University of California, Davis, June 22-25, 1975. 23 p. 1 fig. 10 tab, 7 ref.

Descriptors: Performance, Feedlots, Oregon, Waste storage, Design.
Identifiers: Model, Retention basins.

The objectives of this study were to develop a cattle feedlot runoff control model, and to utilize the simulation model to determine relationships between historical climatological data and performance of various runoff retention system designs. The sufficient design method was used to determine the minimum storage volume required to prevent illegal discharges as defined by the DPW Effluent Guidelines. In some locations the use of high capacity irrigation equipment allowed reduction of the storage capacity by over 45 per cent when a larger pumping system was specified. In other locations, due to the precipitation pattern, no benefit was obtained by the use of pumping equipment with capacity in excess of 0.10 (10 year-24 house storms). Utilization of the sufficient design technique requires the compilation of weather data for a unique climatological region under consideration. The model is relatively inexpensive to operate and a complete climatological region can be analyzed for less than $20, once the regions climatic data are computerized. (Cameron-East Central)

### 2538 - A9, E3 400

### FRESH WASTES HAVE MORE NUTRIENTS,

Egg Industry, Vol. 5, May, 1972, p. 54-55

Descriptors: Poultry, Performance, Diets, Proteins, Nutrients.
Identifiers: Refeeding, Dried poultry wastes, Storage time, Production.

The longer poultry manure is stored before dehydration, the less the nutrient value of the dried poultry waste (DPW) will be. A study revealed that protein in DPW produced from manure stored four weeks or less was 30.2 per cent or higher, while DPW produced from the manure stored five weeks or longer ranged from 18.3 to 27.4 per cent. In a second trial, a slight increase in phosphorus was noted (from 2.4 to 2.8 per cent for birds on 12.5 per cent DPW diet, from 2.6 to 3.2 per cent for birds fed 25 per cent DPW diet). Calcium went from 10 per cent in the first week to 7 per cent after the 31st cycle for birds fed 12.5 per cent DPW. Hen-housed production on the 12.5 per cent diet was 62.4 per cent, compared to 59.2 per cent for the 25 per cent diet and 50.6 per cent for the controls. (Cameron-East Central)

### 2539 - A1, D1, E3 400

### MANURE DISPOSAL POSES PROBLEM,

Feedstuffs, October 8, 1960, p. 24

Descriptors: Poultry, Waste disposal, Fertilizers, Costs, Economics, Dehydration.
Identifiers: Processing, Composting, Pelleting.

Disposal of manure seems to be increasing despite its value. Satisfactory disposal is important to many poultrymen who do not grow crops because of the relation of the manure to general sanitation and control of disease and parasites on the farm. An apparent answer is the development of practical and economical machinery which will handle and transport the bulk at costs which will allow a profit. Increased use of poultry manure can be secured only through successfully meeting the competition of manufactured fertilizers. This requires a processing operation with the following phases: (1) dehydration of the manure, (2) composting, and (3) pelleting or crumbling. Pelleting and crumbling increase the cost of the final product. Only where special efforts have been made to promote the sale of the product can anyone hope to cover these processing costs and secure a profit. (Cameron-East Central)

### 2540 - A1, E2 400

### APPLY MORE, NOT LESS, POULTRY LITTER TO REDUCE POLLUTION,

USDA and University of Georgia
A. P. Barnett, W. A. Jackson, and W. E. Adams
Crops and Soils reprint, 1969, 1 p. 1 tab.

Descriptors: Agricultural runoff, Ammonia, Water pollution, Poultry, Litters, Georgia.
Identifiers: Land disposal, Application rates.

Spreading poultry litter on cropland can cause pollution if large amounts of ammonia nitrogen enter surface water runoff. Results from tests utilizing a rainfall simulator have revealed that ammonia runoff may be reduced by applying heavy rates of litter. With heavy rates of litter the combination of initial infiltration of rainfall into the soil, and water held on the surface and in the litter itself is greater than with lower rates, thus less water runs off. It was found that the most practical application rate is 10 tons an acre because with less than 2 inches of rainfall, runoff is very low and because rainfall of more than two inches is rare. (Merryman-East Central)

### 2541 - B1, D2, D4, E3 100

### RECOVERING PROTEIN FROM DAIRY CATTLE WASTES,

Agricultural Engineering Department, Purdue University, West Lafayette, Indiana
J. C. Nye, A. C. Dale, T. W. Perry, R. B. Harrington, and E. J. Kirsch
Transactions of the ASAE, Vol. 17, No. 6, p. 1155-1160, November-December, 1974. 1 fig, 6 tab, 20 ref.

Descriptors: Proteins, Dairy industry, Separation techniques, Microorganisms, Substrate, Feeds.

If the growing World's population is to be fed, a technique for hastening the passage of nutrients through the food cycle is needed. The objectives of this study were: (1) determine the optimum particle size limit and dilution level for separation of usable feed and feed residue from dairy cattle manure, and (2) evaluate the feasibility of growing microorganisms on manure and then harvesting them as a source of protein for animal feed. The significance and limitations of the study were briefly examined. The researchers harvested a protein product which appeared to be chemically sound as demonstrated by the amino acid analysis. The microbial product was an adequate feed supplement as 20 per cent of the ration. However, the inability of rats to use this product as their only protein source indicated that more work is needed for process refinement. This study did not determine the ability of animals other than rats to utilize the microbial protein. The study showed that separation of dairy cattle feces through a 595 micron opening removes a low quality roughage material from the remaining liquid waste. The liquid waste that was removed provided a suitable substrate for bacterial growth. The bacteria grown were a satisfactory protein supplement when containing 30 per cent crude bacteria. Such a system was found to be economically feasible for livestock operations. (Penrod-East Central)

### 2542 - A4, A5, B2, E2, E3 100

### DEVELOPMENTS IN HOG MANURE DISPOSAL,

Editor, Hog Extra Edition, Farm Journal, Ames, Iowa
D. C. Wolf
Transactions of the ASAE, Vol. 8, No. 1, p. 107-109, 1965.

Descriptors: Waste disposal, Lagoons, Cleaning, Design, Sprinkler irrigation, Energy.
Identifiers: Swine, Land disposal, Settling tank.

The ideas for manure disposal are appearing in two phases: (1) cleaning pens, and (b) disposing of the manure on fields. The problem of cleaning has fairly well been solved with three types of self-cleaning pens. They are: (1) solid floor with a deep, narrow gutter at one end of the pen, (2) partially slotted floor, usually with a four-foot section of the pen floor slotted, and (3) completely slotted floors with a liquid-manure storage pit underneath that is the same size as the building. Factors which determine how clean pigs keep their pens are: (1) size and shape of pen, (2) number of pigs per pen, (3) arrangement of pen, (4) method of feeding, and (5) temperature control. Optimal conditions are described. The first decision a farmer has to make when considering a liquid manure system is whether or not he wants to spread it on his fields to utilize its fertilizer value in crop production. He must weigh the factors of costs, time, labor and nuisance in making this decision. An option to manure spreading is lagooning, but this disposal method has drawbacks too. Groundwater pollution and odor may become problems. Faced with this situation some hog producers are trying a four stage system in which manure from a settling tank is disposed of on the land, but the liquid is disposed of in a lagoon. Other methods being tried are sprinkler irrigation and gas recovery for the purpose of generating electricity. (Penrod-East Central)

### 2543 - A5 100

### METHODS FOR MEASURING SHORT-CHAIN FATTY ACIDS AND AMMONIA FROM ANIMAL WASTES,

Microbiologist and Biological Sciences Technician, respectively, U S Department of Agriculture, Lincoln, Nebraska
L F Elliott and T A Travis
Soil Science Society of America Proceedings, Vol 39, No 3, p 480-482, May-June, 1975 1 fig, 2 tab, 14 ref

Descriptors: Odor, Gas chromatography, Nitrogen compounds
Identifiers: Fatty acids, Flame-ionization detector, Amines

Since it is extremely difficult to identify all odorous compounds that evolve from confined animal areas, a possible alternative would be to identify some specific compounds and/or groups of compounds that may be key contributors to odors The objective of this report is to describe methods suitable for concentrating and measuring short-chain fatty acids and for separating $NH_3$ from the other volatile N compounds that may be trapped from air The limit for the flame-ionization detector used in the study was determined to be 10 g/ml with a 1-uliter injection The per cent recovery generally increased as the fatty acid level increased Acetic acid was an exception Study data indicated that short-chain fatty acids can be partially purified and recovered with reasonable accuracy from an NaOH trapping solution Steam distillation recovery ranged from 61 to 95 per cent Although light-chain amines interfered slightly with the Nessler's method of $NH_4$-N measurement, the interference was much less than with the other methods tested Methylamine and ethylamine N interference was much less than with the other methods tested Methylamine and ethylamine N interference was only about 6 per cent of the equivalent $NH_4$-N (Penrod-East Central)

### 2544 - A9, E2 100

### LAND DISPOSAL OF BROILER LITTER— CHANGES IN SOIL POTASSIUM, CALCIUM, AND MAGNESIUM,

Soil Scientists, U S Department of Agriculture, Watkinsville, Georgia
W A Jackson, R A Leonard, and S R Wilkinson
Journal of Environmental Quality, Vol 4, No 2, p 202-206, March-April, 1975 5 fig, 3 tab, 20 ref

Descriptors: Potassium, Calcium, Magnesium, Soil profile, Cattle
Identifiers: Land disposal, Broiler litter, Grass tetany

The objective of this study was to provide a description of the effects of heavy broiler litter applications on the calcium, magnesium, and potassium content in Cecil soil and the increased potential for causing grass tetany in fescue grass Small plots of Cecil soil established in Kentucky-31 tall fescue were surface applied semi-annually for 2 years with 0, 22.4, 44.8, 89.6, and 134.4 metric tons/ha of broiler litter Calcium wasn't leached as completely as were potassium and magnesium from the litter, even at the 134.4 metric tons/ha rate At the highest application rate, 80 per cent of the applied calcium remained in the litter after 2 years However, at the same rate, 99 per cent potassium and 88 per cent magnesium had been leached from the litter and presumably moved into the soil Perhaps the most important observation made was the exchangeable calcium depletion in the profile with increased rates and between years At the highest application rate, exchangeable calcium is evidently depleted faster than magnesium, and potassium remains the predominant cation Imbalances in potassium, calcium, and magnesium could occur in the grass and soil under long term relatively heavy application of poultry litter to fescue pasture These conditions may contribute to the potential grass tetany hazard in cattle grazing fescue fertilized in this manner (Penrod-East Central)

### 2545 - A8, B1 300

### INTEGRATED FLY CONTROL ON POULTRY RANCHES,

Division of Biological Control, California University, Riverside
E F Legner, W R Bowen, W F Rooney, W D McKeen and G W Johnston
California Agriculture, Vol 29, No 5, p 8-10, May 1975 2 fig, 1 tab

Descriptors: Predators, Scavengers, Poultry, California
Identifiers: Fly control, Parasites, Manure height, Manure stability

Twelve ranches in th San Bernadino-Chino area of California were randomly selected for the study of fly control Six of the ranches served as test ranches for supervised fly control and the other six served as controls All twelve ranches were roofed, had no walls, and contained laying hens in suspended wire cages along concrete aisles Routine fly control practices were already being employed on all ranches Additionally, supervised ranches utilized a careful manure removal plan in which a minimum residual deposit of at least 6.5 inches was retained following cleaning operation in order to sustain a maximum fly predator and scavenger population and also to hasten manure decomposition The minimum manure height that was determined to be essential for minimum fly production was 8-12 inches Stability of the manure was found to be an important factor in integrated fly control Seven species of flies breeding in poultry manure were significantly reduced over a twenty month period through procedures that favored the natural increase of predatory and scavenger arthropods and periodic innoculative releases of four parasitic Hymenoptera The study indicated that there appeared to be some merit in parasitic releases that occurred during the springtime, when fly reproduction is favored through lower area density of predators and native parasites (Penrod-East Central)

### 2546 - A1, B1, D4, E2, E3 600

### NUTRIENT CONSERVATION IN ANIMAL WASTE MANAGEMENT,

Agricultural Engineering Department, Clemson University, Clemson, South Carolina
D T Hill and C L Barth
Presented at 1975 Annual Meeting, American Society of Agricultural Engineers, University of California, Davis, June 22-25, 1975, 17 5 fig, 3 tab, 17 ref

Descriptors: Technology, Nutrients, Nitrogen, Biological treatment
Identifiers: Waste management, Land disposal techniques, Ensiling

This paper discussed common waste management processes, their technological complexity, and their nutrient management characteristics Particular emphasis is given to nitrogen control The methods are discussed from the points of view of "existing technology" and "developing technology" Nitrogen can be managed within certain limits with existing technology Such technology includes: ponds, lagoons, pit storage systems, oxidation ditches, and anaerobic digestion Newly developing technology is more costly and complex to construct and operate; therefore, it can probably be justified only where large scale operation makes it economically feasible Developing technology offers more control over nitrogen form and nitrogen loss However, it is not possible to conserve 100 per cent of the nitrogen Developing technology includes physical processes (such as screening), ensiling, controlled liquid biological processes, and land application techniques (Penrod-East Central)

### 2547 - A1, B1, E2, E3, F1, F2, 400

### ON THE HORNS OF THE DIARY WASTE DILEMMA,

Farm advisors for LA, Orange, Riverside, and San Bernadino counties, California
F F Smith, S E Bishop, J C Oliver, W C Fairbank, W W Wood, Jr., and C L Senn
Western Dairy Journal, Vol 31, No 9, p 10-13, July, 1975

Descriptors: Dairy industry, California, Regulation, Costs
Identifiers: Earth corrals, Recycled Aerated Manure (RAM), Pollution control

The impact of new requirements on the Southern California Dairy industry is examined At least eight factors have been found to influence the choice of waste management alternatives—land values (investment costs); land taxes; cow density (or manure application) limitations imposed by water control agencies; cow density limitations imposed by local governmental planning authorities; production responses attributable to the side effects of waste management facilities (heat, cold, mud, rain, etc ); operating costs; and net revenue realized from cropland used for waste disposal A method is presented for assessing these variables The profitability of dairying in Southern California is determined mainly by land values and pollution prevention requirements. A comparison is made of two management systems—(1) the earth corral and (2) the Recycled Aerated Manure System (RAM), in which cows are maintained in roofed, open-sided structures, with air-dried manure used as absorbent bedding Waste management investment costs are $167 per cow and $38.50 per cow for RAM and earth corral systems, respectively "All other costs" for the year are $760 and $775 for RAM and the earth corral, respectively. RAM provides (1) conditions for cleaner cows, (2) a more compact layout, (3) a more convenient site for examining and treating cows, (4) better udder health, (5) fewer foot or leg injuries, and (6) reduction in fly control costs It is concluded that the RAM system offers a viable and competitive solution for waste management (Penrod-East Central)

### 2548 - A9, E3 200

### EVALUATION OF DEHYDRATED POULTRY WASTE AS A FEED INGREDIENT FOR POULTRY,

Department of Poultry Science, Texas A&M University, College Station
J R Couch
Presented at Proceedings of the 28th Annual Texas Nutrition Conference, October 3-4, 1973, p 121-126 17 ref

Descriptors: Poultry, Feeds, Calcium, Phosphorus, Amino acids, Proteins
Identifiers: Dehydrated poultry wastes, Refeeding, Energy content, Feed conversion

The following tentative definition was adopted at the annual meeting of the Association of American Feed Control Officials, Inc : "Dried Poultry Waste (D.P.W.) is a product composed of freshly collected feces from commercial laying or broiler flocks not receiving medicants . . . terminally dehydrated to a moisture content of not more than 15 per cent. It shall not contain any substances at harmful levels . . . be free of extraneous materials such as wire, glass, nails, etc The product shall be labeled to show the minimum per cent protein, minimum per cent fat and per cent fiber It may be used as an ingredient in sheep, lamb, beef and dairy cattle, broiler and layer chick feeds Broiler and laying rations shall be limited to 20 per cent and 25 per cent D.P.W. respectively." The FDA has not yet passed approval of this product. Fecal material collected from caged poultry and not contaminated with litter can be fed to laying hens at a level of up to 25 per cent without detrimental effects While D.P.W. has value as a source of calcium, phosphorus, and amino acids, it is low in energy and protein D.P.W. affects feed conversion adversely on a linear basis as the level in the diet increases While it is felt that D.P.W. will be used in feed formulations of the future, it appears to have no value for broilers. (Penrod-East Central)

### 2549 - A1, D4, E3 100
### SLUDGE DIGESTION OF FARM ANIMAL WASTES,

Department of Agricultural Engineering, Iowa State University, Ames
E. P. Taiganides, E. R. Baumann, and T. E. Hazen
Compost Science, Vol. 4, No. 2, p. 26-28, 1963. 2 fig, 1 tab, 12 ref.

Descriptors: Sludge digestion, Economics, Feasibility, Costs, Stabilization, Temperature, Methane.

Advantages of the digestion process for treating farm animal wastes are: (1) Organic matter is reduced 50-70 per cent, (2) Raw waste is stabilized, (3) Digested waste is thick, free-flowing, and odor-free, (4) Rodents and flies are not attracted to the end products of digestion, (5) Fertilizing constituents of the digested solids are higher than that of raw waste, (6) Commercially valuable combustible gases are produced when sufficiently high rates of digestion are maintained. Disadvantages are: (1) High initial investment, (2) Residue disposal, (3) Need for supervision of feeding the digester, and (4) Necessity of preventing intrusion of atmospheric air into the digester. Optimum digestion is obtained at 95 degrees F. The practical range of solids concentration of wastes entering the digester is 7-10 per cent. Capacity of the digester must be 10-30 times as large as the daily volume of waste digested. Sudden drops in temperature, overfeeding, and formation of a thick hard scum layer must be avoided. The value of digestion of animal wastes lies in the utilization of the methane gas and in the production of an end product that is more desirable than the raw manure. (Penrod-East Central)

### 2550 - A1, B2, F1 100
### TREATMENT OF DAIRY WASTES BY MECHANISED BIOLOGICAL METHODS,

Scientists, CPHERI, Nagpur, India
S. R. Alagarsamy and B. B. Bhalerao
Indian Journal of Environmental Health, Vol. 14, No. 3, p. 225-235, 1972. 3 fig, 1 tab, 5 ref.

Descriptors: Waste treatment, Dairy industry, Aerated lagoons, Design, Costs.
Identifiers: India, Oxidation ditch, Mechanised biological treatment.

Because wastes from dairy plants are rich in degradable organic matter and exert a high oxygen demand, adequate treatment is necessary. The degree of treatment depends on its mode of disposal either into water courses or on to land for irrigation. Among the mechanized biological methods available, the aerated lagoon and the oxidation ditch are relatively easier to install and operate. Only partial treatment by aerated lagoon with 1.15 days detention time is sufficient for disposing the final effluent on to land for irrigation. An oxidation ditch should be used where the treated effluent is intended to be discharged into water courses. The waste treatment problem of a dairy with large capacity has been considered as a case study and detailed designs and cost studies for aerated lagoon and oxidation ditch methods have been worked out. (Cameron-East Central)

### 2551 - C2, C3 100
### COMPARATIVE EVALUATION OF SOME TECHNIQUES USED IN DETERMINATIONS OF NITROGEN AND ENERGY CONTENT OF FECES FROM PIGS,

Department of Animal Science, Alberta University, Edmonton 7, Alberta Canada
H. S. Saben and J. P. Bowland
Canadian Journal of Animal Science, Vol. 51, p. 793-799, December 1971. 4 fig, 1 tab, 7 ref.

Descriptors: Analytical techniques, Nitrogen, Energy.
Identifiers: Swine, Feces.

Studies were undertaken to evaluate some techniques used in swine digestibility studies: (1) comparison of N content as determined on wet or dry feces from pigs fed either high or low protein diets; (2) comparison of energy content as determined on wet and dry feces; and (3) effect of length of digestion time, using the Kjeldahl method, on the determined N content of fecal material. Analysis of variance indicated no significant difference between the mean values for N content, whether determined from wet or dry fecal material from diets containing 39 or 18 per cent crude protein. The mean N loss between wet and dry determinations was .87 g/pig over the 3 day sampling period, which represents a nonsignificant 3.7 per cent N loss. No significant difference was observed between the fecal energy excreted, when analyzed in the wet or dry form. The mean energy loss was 5.0 per cent between the wet and dry material. The difference between the duplicate sample determinations never exceeded 3 per cent for N or 2 per cent for energy, but N and energy determinations on wet fecal material gave consistently greater standard errors than those on dry fecal material. These results suggest that either wet or dry fecal material may be used for N and energy determinations in pig digestion trials, without significantly influencing results obtained. (Cartmell-East Central)

### 2552 - A1, B2, E2 400
### MOST PIG WASTE DISPOSAL SYSTEMS SATISFACTORY,

Soil and Water, Vol. 10, No. 2, p. 46, December 1973.

Descriptors: Lagoons, Design, Waste disposal, Pumps.
Identifiers: New Zealand, Swine, Tanker systems.

A recent Pork Industry Council survey indicated that about 70 per cent of New Zealand's pig farms have satisfactory waste disposal systems. Areas having waste disposal problems were the Northland and the Bay of Plenty. Overloaded lagoons and inadequate pumping equipment appeared to be among major complaints. It was observed that in the future the local pig advisory officer or regional water board engineer should be involved at the design stage of a lagoon installation. It was also felt that larger pumps should be used to combat blockage problems. (Kehl-East Central)

### 2553 - B2, D4 700
### THE USE OF INDOOR LAGOONS FOR MANURE DISPOSAL IN HIGH DENSITY SYSTEMS OF POULTRY MANAGEMENT,

A. A. Al-Timimi
M.S. Thesis, Department of Poultry Husbandry, University of Nebraska, Lincoln, June, 1963. 51 p. 5 fig, 14 tab.

Descriptors: Lagoons, Poultry, Design, Sampling, Performance, Bacteria, Temperature.
Identifiers: Indoor lagoons, pH, Dry matter.

Two experiments were conducted to test and evaluate the indoor lagoon system for manure disposal under laboratory conditions. It was concluded that the primary consideration in calculating the duration of function of indoor lagoons between cleanouts is the cubage involved. It does not appear practical to aerate because no beneficial effects of aeration on dry matter accumulation were observed using 57 cc of air per minute per cu. ft. of water. Surface may be important in balancing evaporation with accumulation of solids to hold a constant level in the pit. A formula was calculated to be used where pit temperatures averaging 78.4 F are encountered. Further work is needed to relate pH, changes, nature of gases produced, and effects of other variables to details of design necessary to improve this system. (Cartmell-East Central)

### 2554 - A2, A8, A9, B1 400
### ENVIRONMENTAL HEALTH AND ANIMAL WASTES,

Texas University, Houston
J. H. Steele
Modern Veterinary Practice, Vol. 53, No. 11, p. 25-29, October, 1972. 3 fig.

Descriptors: Environmental effects, Animal wastes, Zoonoses, Vectors, E. Coli, Water pollution.
Identifiers: Anthrax, tuberculosis, leptospirosis, salmonellosis, brucellosis.

Over 100 animal diseases can be transmitted to man and many of these may be transmitted through animal wastes. This report examines the modes of transmission of several zoonoses and the effects that waste management has on their presence in livestock production units. Among the diseases discussed are: anthrax, salmonellosis, tuberculosis, brucellosis, leptospirosis and E. coli. Possible pollution of waterways with these diseases compounded by the encroachment of urban areas on agricultural zones makes livestock waste management very important in environmental health. New methods of waste management should be evaluated to ensure that they will not permit multiplication of insect and rodent vectors of disease, nor increase the animal reservoir of zoonotic diseases. Other factors to be considered in evaluating a waste management method are: (1) does it allow drainage or leaching of materials containing pathogens to a groundwater source; (2) does it constitute a means for transmitting disease from animals to man; (3) does it allow a building up, in an animal population, of levels of potentially toxic chemicals; and (4) does it support added sources of fungal contamination of the environment. Since feedlots are increasing, new methods should be developed to ensure animal health and chemical conversion to fuel oil and by-products. (Penrod-East Central)

### 2555 - A5, A8, B1, D4, E3 300
### TWO TYPES OF DIGESTERS UNDER STUDY AT MSU . . .ANIMAL WASTE MANAGEMENT

Montana Agricultural Experiment Station, Montana State University, Bozeman
J. Boyd and C. Milne
Now, Spring, 1974, p. 10-11. 2 fig.

Descriptors: Aerobic treatment, Anaerobic digestion, Animal wastes, Montana, Fermentation, Odor, Nutrients, Recycling.
Identifiers: Oxidation ditch, Flies, Gas production, Refeeding, Germination cups.

The objectives of animal waste management studies carried out at the Montana Agricultural Experiment Station are: (a) study methods of odor elimination, (b) eliminate animal waste as breeding area for flies, (c) conserve the maximum nutrient content of the waste, and (d) find new ways of processed material utilization besides land application. Two systems were studied as to the effectiveness in odor elimination and conservation of waste nutrient content. The first one involved aerobic fermentation of the waste material by incorporating air into an animal waste slurry of about 10 per cent solids (oxidation ditch). The second system was an anaerobic digestion process for fermenting the waste. Because this process produced a methane-carbon dioxide gas mixture, the gas produced by one such digester was used to stir or agitate another digester, recycling the sludge in order to conserve the maximum number of digestion organisms. Through various studies, additional uses have been found for the processed waste material. They are: (1) refeeding, and (2) manure germination pots. Additional research is needed, in order to perfect the processes and make them economically feasible. (Penrod-East Central)

**2556 - A1, E2 300**

### WATER QUALITY AND SOIL EROSION FROM SURFACE APPLICATION OF TREATED LIQUID SWINE WASTE,

R. W. Gunther
MS Thesis, Agricultural Engineering Department, University of Illinois, Urbana-Champaign, 1974, 82 p. 5 fig, 31 tab, 23 ref

Descriptors: Water quality, Soil erosion, Agricultural runoff, Liquid wastes, Waste disposal, Percolating water.
Identifiers: Land disposal, Swine, Soil solids, Universal soil loss equation.

Waste products disposal is a problem faced by both rural and urban people. Because of stricter regulation and the limited technology and capital available to meet these standards, these groups are giving more consideration to land application of wastes. This study's objectives were: (1) study the quality of runoff and percolate from a rainfall event on soil which has received various applications of treated liquid waste; (2) investigate waste application effects on soil erosion; (3) develop a manure erodibility factor and a soil erodibility factor to use in the universal soil-loss equation, for a soil that has had treated liquid waste applied on the surface. The procedures for the study are given. The following conclusions were drawn: (1) Although the percolate had high nitrate concentrations, the percolate from manured soils was of better quality than the runoff; (2) the application of liquid swine waste on soil caused an increase in percolation through the soil that corresponded to the decrease in runoff from a rainfall event; (3) volatile solids were more easily eroded than non-volatile solids; (4) because of the decreased volume of runoff and the surface stabilization effect of waste, and therefore, the decreased COD load placed on the stream, runoff from soils that have had liquid wastes applied to them may be less of a pollution hazard to streams than runoff from bare soil; (5) a new slope length factor was determined for a three foot slope length for the universal soil-loss equation; and (6) as compared to runoff from bare soil, runoff from soils where liquid waste had been applied contained fewer soil solids. (Kehl-East Central)

**2557 - A1, E3 600**

### LAND AND CROP UTILIZATION OF ANIMAL MANURE AT FIVE MINNESOTA LOCATIONS,

North Central Experiment Station, Minnesota University, Grand Rapids
P. R. Goodrich, J. J. Boedicker, E. C. Miller, J. D. Evans, and G. W. Randall
Presented at 1973 Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-430, 16 p. 16 tab.

Descriptors: Minnesota, Crop response, Chemical analysis, Soil analysis, Nutrients, Salts.
Identifiers: Land disposal, Application rates.

Manure was used as fertilizer on various experimental plots in Minnesota in an attempt to investigate the problems associated with the application of manure. The investigation was aimed at lowering hauling costs and protecting soil productivity, groundwater quality, and crop yields. Extensive soil and manure samples were analyzed for total nitrogen, ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, conductivity, chlorides, potassium, sodium, and pH. Emission spectograph analyses were performed on manure samples for phosphorus, potassium, calcium, aluminum, sodium, iron, magnesium, zinc, copper, molybdenum, manganese, and boron contents. Three types of manure were applied in the fall of 1970 and again in the fall of 1971: solid beef manure at 100 tons-acre, liquid beef manure at 284 tons/acre, and liquid hog manure at 284 tons/acre; the fertilized plots were planted with corn in 1971, 1972, and 1973. The following observations were drawn from this study: (1) Although there were some mechanical problems, it was found that manure can be successfully applied at these rates. (2) At these rates of manure application, the plant food application rate was quite high. (3) The high salt content in the manure increased soil conductivity, but only damaged plants receiving the liquid beef manure. (4) Yields from plots receiving manure were not statistically different from plots receiving inorganic fertilizer. (5) Though manure applications increased nitrate-nitrogen and chloride levels in the soil, there was no apparent movement of nitrate-nitrogen below three feet. (Sanders-East Central)

**2558 - A9, B1, E3 300**

### CHICKEN LITTER AS A SUPPLEMENT IN WINTERING BEEF COWS AND CALVES ON PASTURE,

M. L. Ray and R. D. Child
Arkansas Farm Research, Vol. 14, No. 4, p. 5, July-August, 1965. 3 tab.

Descriptors: Litters, Feeds, Cattle, Performance.

In 1964, a cooperative experiment was initiated to study methods of feeding chicken litter to lactating beef cows. 120 brood cows were divided into four units of 30 head each. The rations fed were: Group I-Litter free choice plus all the hay that would be cleaned up before the following day; Group II-Free choice hay only; Group III-Litter that cows and calves would clean up in two hours plus all the hay they would clean up in 24 hours; Group IV-Free choice litter only. All the calves were creep fed. Each group was kept on a high quality stand of tall fescue which furnished considerable grazing throughout the wintering period. Weights, grades, and condition scores were recorded for the cows and their calves on December 1, 1964, when the test started and again on April 15, 1965, when the test ended. Daily feed intake was recorded by groups. Groups ranked by weight loss (from greatest to smallest) were II, I, IV, and III. Groups ranked by weight gains of calves (from greatest to smallest) were III, IV, I, and II. The calves in group IV were as bloomy as those in the other groups and the cows evidently produced as much milk as cows in the other groups. Study results indicate that cow herds can be wintered economically on Kentucky 31 fescue pastures supplemented with broiler house litter and an energy source without any expectation of harmful effects on the cows or calves. (Merryman-East Central)

**2559 -A1, B1, E2 600**

### COMPARISON OF DESIGN CRITERIA AND PERFORMANCE OF WASTE HANDLING SYSTEMS,

Agricultural Engineering Department, Michigan State University.
T. L. Loudon, R. L. Maddex, and C. H. Shubert
Presented at 1975 Annual Meeting, American Society of Agricultural Engineers, University of California, Davis, June 22-25, 1975, 14 p. 2 tab, 1 ref.

Descriptors: Design criteria, Michigan, Performance, Dairy industry, Cattle, Agricultural runoff.
Identifiers: Waste handling systems, Swine, Land disposal.

A research study is under way in Michigan to evaluate animal waste handling systems on 24 dairy, beef, and swine farms. In some instances the complete system is being studied, while in other instances only a specific component of the system is under study. Data collection is performed by both the farmer and the project personnel using basic instrumentation for measurement of precipitation, manure level in storage facilities and temperatures in selected manure storage facilities. Manure storage facilities and runoff retention ponds are receiving particular attention, comparing design expectations with actual land application, and handling method. Observations that have been made may be summarized as follows: (1) Few manure storage facilities function exactly as planned. A common area of discrepancy between design and performance is the storage period achieved. (2) A storage facility designed for both manure and runoff is difficult to manage if the only land application method is a liquid manure spreader. (3) Hauling manure from a concrete bunker storage facility which doesn't provide for draining liquids away is not feasible with a conventional loader and spreader. (4) Total waste production in a farrowing building including washdown waste water averages 1.17 $ft^3$/sow/day. (5) The best times to empty manure storages in Michigan are during winter or after hay harvest. (6) Peak labor demands for waste handling may be considered second priority if cropping programs labor demands are high. (7) Michigan farmers apparently consider management of runoff ponds as a low priority item. (Penrod-East Central)

**2560 - B1, D2, E3 400**

### COLORADO DPW PROCESSING FIRM FINDS READY MARKET AS BOTH FEED, FERTILIZER,

B. M. Wilkinson
Feedstuffs, Vol. 47, No. 33, p. 7, August 18, 1975. 3 fig.

Descriptors: Colorado, Poultry, Feeds, Fertilizers, Dehydration.
Identifiers: Dried poultry waste.

A new dried poultry waste (DPW) processing plant in Colorado began operations in March and since has been having difficulties just keeping up with demand for DPW. The waste is being sold to feed manufacturers for as high as $72 a ton, according to Stanley K. Hill, Vice-president of Organic Products, Inc., the DPW firm. Sunnymead, the poultry farm supplying this plant, is expected to make $18,000 to $20,000 annually from the DPW. The cost of establishing the DPW plant was under $200,000. The DPW is also being marketed as fertilizer under the brand name TIARA in order to keep the plant operating in slack feeding periods. The cattle don't seem to mind DPW in their feeds, although one feedlot reported rejectance when DPW was abruptly added in place of a familiar ingredient for 6 per cent of the total ration. Hill advises that DPW be added gradually to the ration. The biggest problem with DPW is drying it; the fresh manure is about 75 per cent moisture, and needs to be around 40 per cent moisture before dehydration is economical and efficient. Fans are used to aerate the DPW before dehydration. The temperature in the drying chamber is kept at about 275 degrees. This is high enough to kill pathogens yet low enough to save nitrogen and micro elements. (Sanders-East Central)

**2561 - A1, B1, F2 300**

### WASTE MANAGEMENT PRACTICES AND SYSTEMS ON MICHIGAN DAIRY FARMS,

Department of Agricultural Engineering, Michigan State University, East Lansing
C. R. Hoglund, J. S. Boyd, L. J. Connor, and J. B. Johnson
Agricultural Economics Report No. 208, Department of Agricultural Economics, Michigan State University, January, 1972. 15 p. 6 tab.

Descriptors: Michigan, Regulation, Dairy industry, Water pollution, Air pollution, Costs.
Identifiers: Waste management.

A survey was conducted in Southern Michigan to collect information concerning manure handling systems, practices, and costs on dairy farms having different herd sizes and housing systems. The information was collected in order to provide a basis for developing investment and cost data for alternative manure handling systems which would take into account varying degrees of air and water pollution control that would be required by the Michigan Water Resources Commission and/or the Michigan Air Pollution Control Commission. The following conclusions were drawn from the 314 surveys that were completed and returned. Dairy housing and manure handling systems were related to herd size, which ranged from 46 cows on farms with stanchion housing and a gutter cleaner-spreader manure handling system to 135 cows on farms with a covered housing/liquid manure handling system. The largest herds, averaging 158 cows, used open-lot housing and liquid manure systems. Acres of cropland on which manure was spread ranged from 4 acres per cow on those farms with stanchion housing to 3 acres per cow on farms with covered housing-liquid manure systems. Most dairymen stated that they had received no strong objections from neighbors about odors from their manure handling systems even though approximately half of them reported a neighbor within one-half mile. Investments in the complete waste management systems ranged from $80 to over $190 per cow, depending on the sophistication of the system. (Sanders-East Central)

### 2562 - A1, B1, D1, E1 100
### RESEARCH AND PRACTICE IN ANIMAL WASTES TREATMENT,

Tippecanoe Laboratories of Eli Lilly and Co., Lafayette, Indiana
R. H. L. Howe
Water & Wastes Engineering, Vol. 6, p. A14-A18, 1969. 4 fig, 7 tab, 6 ref.

Descriptors: Animal wastes, Waste treatment, Regulation, Research and development, Coagulation, Stabilization, Activated sludge, Lagoons, Oxidation.

Because of stricter pollution regulations and the need of producing more food to meet the needs of a growing population, the problem of animal and dairy wastes has been intensified. The purpose of this study is to present research and developmental work conducted by the author and his colleagues. In the feeding industry, animal wastes are defined as including: waste feed, excreta, bedding material, washings, and spills. Among research in wastes disposal methods, the Institute of Advanced Sanitation Research, International has initiated a cooperative project, involving several member-scientists, primarily for the investigation of the characteristics of various animal wastes before and after treatment. The author states that it is their finding that solid wastes and liquid wastes must be separated and handled differently for reasons of economy. Also being investigated are physical and chemical methods of animal wastes treatment. The search for an economical coagulant has led the author and his colleagues to develop a very promising inorganic polymeric coagulant which has been tested in plant-scale operation. Animal processing wastes vary in terms of their characteristics. The main problems in treating these wastes are caused by: blood, color, solids, BOD, grease, hairs, and proteinaceous particles. In treating animal processing wastes, effective and proper methods of stabilization are needed. Several methods of stabilizing biological sludge and dairy wastes are given. The author discusses various research needs. Mr. Howe says that it is believed that segregation of strong wastes from weak would be appropriate. (Penrod-East Central)

### 2563 - A1, E2 700
### SOME EFFECTS OF BEEF FEEDLOT EFFLUENT APPLIED TO A FORAGE SORGHUM,

J. E. Sukovaty
Unpublished MS Thesis, University of Nebraska, May, 1973, 61 p. 13 fig, 13 tab, 41 ref.

Descriptors: Agricultural runoff, Feedlots, Crop response, Sorghum, Nutrients, Effluent, Waste disposal, Legislation.
Identifiers: Land disposal, Detrimental effects.

An increased food need has caused increased beef production, resulting in an increase in feedlots. The animal wastes from these facilities present potential runoff, groundwater and air pollution problems. Legislation has stated that runoff must be collected. Once this is done, it must be disposed of properly. Before effluent disposal on cropland is recommended, several questions should be answered. Such questions encompass nutrient value, detrimental effects of the effluent, and possible soil pollution problems. Data analysis obtained for a two year effluent disposal study revealed definite treatment differences between effluent and water applications. High rates of effluent application were observed to have an additive effect on $NO_3$-N concentrations in harvested plants for 1972. Such an effect was not observed for 1971. The addition of phosphorus to the surface four inches of soil was linearly related to increasing effluent application over the two year period. Effluent addition to cropland showed an increase in soil solution of Na, Ca, and K. Data from the two year study indicate the 1-inch effluent application appeared to have the most beneficial results. Other than an increase in P accumulation, the addition of 2-inches of effluent per week did not show beneficial results over the 1-inch effluent application. The study concluded that negative yield response may be offset by the increase efficiency of waste disposal. Points that should be considered if this type of disposal is used are: (1) nutrient and salt concentrations in effluent, (2) soil texture and area of available land, (3) local precipitation and climatic factors, and (4) size of operation. (Penrod-East Central)

### 2564 - A4, B1 700
### PHYSICAL CHARACTERISTICS OF THE SURFACE AND INTERFACE LAYERS OF A LEVEL BEEF CATTLE FEEDLOT,

L. N. Mielke
PhD Dissertation, Nebraska University, Lincoln, April, 1974, 166 p. 14 fig, 49 tab, 77 ref.

Descriptors: Cattle, Permeability, Sampling, Soil profiles, Groundwater pollution.
Identifiers: Feedlot surface, Interface layer, Organic materials, Inorganic materials, Soil cores.

The object of this study was to measure the physical changes that occur in soil under the influence of a beef cattle feedlot. Special emphasis was given to the interface zone formed between the inorganic and organic material near the soil surface. A soil sampling technique was developed using heat-shrink plastic tubing to encase undisturbed cores. The cores obtained were very adequate for laboratory study of the soil conditions beneath the feedlots. Water movement into the profile was greatly restricted by the combination of animal wastes and cattle tramping. This action also increased the bulk density of the top 15 to 20 cm of the profile and caused the formation of a boundary or interface layer between the organic and inorganic materials. Mixing of soil and organic matter occurred below and above interface boundary that was formed. The interface layer influenced the movement of air, water and nutrients into the soil profile and into the groundwater. Other soil cores from the cropland and feedlot were segmented into sections about 10 cm long. Observations of these sections are given. Chemical analysis of percolate from the soil sections showed the highest concentration of Na and K in the interface layer. The dispersing effect of Na and K in the soil together with the compaction by hoof action resulted in a very poor physical condition at the feedlot soil surface that limited the movement of water and air. (Penrod-East Central)

### 2565 - A1, B1, D1, E2, E3 200
### SANITARY ENGINEERING IN AGRICULTURE,

Department of Agricultural Engineering, California University, Davis
S. A. Hart
Transactions of the Fourteenth Annual Conference on Sanitary Engineering, The Bulletin of Engineering and Architecture No. 52, The University of Kansas, Lawrence, 1974, p. 5-10. 8 fig, 15 ref.

Descriptors: Drying, Oder, Lagoons.
Identifiers: Agricultural wastes, Waste management, Composting, Land disposal.

Depending on the definition used, there are four or five kinds of agricultural wastes: (1) livestock manures, (2) crop residues, (3) dead animals, (4) agricultural chemicals, and (5) runoff water and eroded soil. Livestock manure is the agricultural waste that creates the greatest problem today. Manure cannot usually be allowed to accumulate in a confinement area until use, because of the sanitation hazards of odors, dust, animal health, fly breeding, or potential water pollution. Therefore, four steps need to be considered in manure management—collection, processing, storing, and utilization. The form of the waste (liquid or solid) determines the type of waste management practices utilized. Manure processing is based on the stabilization of a waste organic matter which is contaminated with water. Drying and composting as stabilizing processes are examined. Processing methods for liquid-carried manure include: digestion, anaerobic lagooning, and possibly aerobic treatment akin to the activated sludge process. The main emphasis on storing manure is that it must be sanitary. Stabilization is very important in preparation for storage. Manure may be disposed of or utilized in several ways, the main method being land application. Other uses are in experimental stages and include (1) recovery of drugs, vitamins, and hormones from the wastes, and (2) use of livestock wastes as a source of fuel. (Penrod-East Central)

### 2566 - A1, B1, D1, E2 200
### NEWER ASPECTS IN TREATMENT OF PACKING HOUSE AND FEEDLOT WASTES,

Oscar Mayer and Co., Madison, Wisconsin
A. S. Johnson
Transactions of the Fourteenth Annual Conference on Sanitary Engineering, The Bulletin of Engineering and Architecture No. 52, The University of Kansas, Lawrence, 1964, p. 10-18. 7 fig, 4 tab, 6 ref.

Descriptors: Waste treatment, Waste disposal, Wisconsin, Feedlots, Farm wastes, Trickling filters, Lagoons, Waste water treatment.
Identifiers: Packing house wastes, Anaerobic stabilization ponds, Composting.

Attempts are being made in Wisconsin to improve the efficiencies of processes utilized in treating packing house wastes. Primary treatment usually includes various combinations of screens, flocculators, sedimentation tanks and dissolved air flotation tanks. Some plants operate trickling filters of packing house waters, for secondary treatment. Other plants use anaerobic stabilization ponds, sometimes in conjunction with trickling filters. The problem of feedlot waste disposal has not to date been subject to review by the Wisconsin Water Pollution Commission, although feedlots are becoming a larger industry in the state. Although return of manure to the soil is still the principal disposal method, improvements in handling facilities and attempts to apply anaerobic ponds to treatment of the wastes appear to be the primary trends in this area. (Penrod-East Central)

### 2567 - A2, B1 200
### STREAM POLLUTION FROM FEEDLOT RUNOFF,

Environmental Health Services, Kansas State Department of Health, Topeka
S. M. Smith and J. R. Miner
Transactions of the Fourteenth Annual Conference on

Sanitary Engineering. The Bulletin of Engineering and Architecture No. 52. The University of Kansas, Lawrence, 1964, p. 18-25. 7 fig, 8 tab.

Descriptors: Water pollution, Agricultural runoff, Feedlots, Kansas, Atmospheric precipitation, Ammonia.

The objective of this report is to indicate that the authors' findings show animal feedlot runoff to be a significant source of water pollution, and to present data which have been collected indicating the nature of the pollution and the behavior of streams after being subjected to this type of pollution. The limited amount of information that seems to be available describing stream pollution may be partly accounted for by the problem of collecting stream samples during or shortly after runoff. The principal data for this Kansas study came from water samples collected from three streams—the Whitewater River near Potwin, the Cottonwood River near Emporia, and Fox Creek near Strong City. The nature of such runoff pollution is described as follows: (a) runoff imposes a slug load on the stream, (b) feedlot runoff is high in ammonia and the resulting stream pollution shows characteristic high ammonia concentration, and (c) a high bacterial population is produced by the runoff. Serious dissolved oxygen content depletion may occur in the stream if the stream is small and the waste load is large. The degree of stream pollution is dependent on a variety of factors: feedlot size, lot cleanliness at time of runoff, area topography and lot location with respect to receiving waters, rainfall intensity, amount and pattern, stream size, and the pollution control measures used. (Penrod-East Central)

## 2568 - C3, D2 700

### THE EFFECT OF DEHYDRATION ON THE CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF MANURE,

C. W. Berg

MS Thesis, Agricultural Engineering Department, North Dakota State University, Fargo, September, 1972, 77 p. 25 fig, 11 tab.

Descriptors: Dehydration, Chemical properties, Nutrition, Dairy industry, Cattle, Moisture content, Temperature
Identifiers: Manure.

An investigation was conducted to determine the effects of drying air temperature, final moisture content and accumulation time on the chemical composition of the dried manure product. Investigators hoped to establish any trends on the chemical composition and nutritive value of the dried manure product that might be caused by the various treatment effects. Manure was collected from dairy steers and consisted of samples which had accumulated for different time periods. The manure was dried down to three different final moisture contents at four temperature levels. The chemical composition of the manure was then determined to obtain the nutritive value of the dried manure product. It was concluded that: (1) Ash, acid detergent fiber, lignin, cell wall constituents, silica, phosphorus, potassium, calcium, and magnesium revealed higher dry weight percentages in the manure than in the feed consumed; (2) An increase in manure accumulation time revealed an increase in dry weight percentages of ash and silica and a decrease in protein, (3) Cell wall constituents increased with increase in final moisture content; (4) Generally, increase in temperature caused an increase in dry weight percentages of silica, fiber lignin, and phosphorus. However, as temperatures increased the amount of cell wall constituents and digestible dry matter decreased; (5) Drying to 8 per cent final moisture content at 200 degrees C gave the highest dry weight percentages and contributed greatly to significant differences of the temperature by final moisture content interaction of ash, silica, fiber, lignin, phosphorus, potassium, and magnesium; (6) Optimum drying conditions would call for collection of manure daily and, if possible, drying it at 100 degrees C to a final moisture content of 8 per cent. (Cameron-East Central)

## 2569 - A1, E2 700

### RATE OF MANURE DECOMPOSITION IN SOIL AND EFFECTS OF SPRINKLER APPLICATION OF LAGOON EFFLUENT ON CORN AND GRAIN SORGHUM,

T. E. Loynachan

MS Thesis, Department of Agronomy, Iowa State University, 1972, 81 p. 7 fig, 23 tab, 84 ref.

Descriptors: Crop response, Sprinkler irrigation, Carbon dioxide, Phosphorus, Nitrogen, Potassium, Salinity
Identifiers: Land disposal, Decomposition, Anaerobic lagoons, Swine.

The main objective of this study was to consider soil as the ultimate medium for manure disposal. Two methods were investigated: (1) application of the complete manure to the soil, and (2) the anaerobic lagooning of the fresh manure followed by application of the effluent to land. In experiment I, hog manure was applied to Webster clay loam soil at the rates of 0, 10, 50, 100, and 200 parts wet manure per thousand parts dry soil. The relative rates of manure decomposition were found to be inversely related to quantity added, while the absolute rates were found to be directly related to the quantity added. Carbon dioxide production rate increased to a peak within two days and then gradually decreased. Rate of and total carbon dioxide evolution were more closely related to amount of carbon added than to moisture level. Results indicated that no more than 100 tons per acre of manure should be applied at any one application to similar soils. In experiment II, swine-lagoon effluent was applied to land growing corn and grain sorghum. Effluent was sprinkler irrigated at rates of 0-17.09 inches from June 21 to August 27, 1971. The effluent had no significant effect on corn yield; however, grain-sorghum decreased up to 53 bushels per acre. Higher rates of effluent application induced lodging of the grain-sorghum heads. Protein in the grain increased with increasing rates of effluent on grain sorghum, but this trend was not observed in corn. Increasing amounts of applied effluent caused increased values of extractable phosphorus and exchangeable potassium in the surface two inches of soil. Salinity also increased. (Penrod-East Central)

## 2570 - A8, A9 100

### BIOCONCENTRATION AND BIOTRANSFER OF AFLATOXIN,

Department of Microbiology, Colorado State University, Ft. Collins

M. P. Nevins and D. W. Grant

Bulletin of Environmental Contamination and Toxicology, Vol. 8, No. 6, p. 552-558, November-December, 1971. 17 ref.

Descriptors: Microorganisms, Toxicity, Feedlots, Cattle, Fish, Health
Identifiers: Bioconcentration, Biotransfer, Aflatoxin, Substrate, Flies

Research was undertaken to isolate aflatoxin-producing strains of Aspergillus flavus from manure and to demonstrate a potential path for the biotransfer and biomagnification of the aflatoxins in a simulated food chain. It was found that toxigenic strains of A. flavus can be readily recovered from stockpiled feedlot manure and that, under certain conditions, aflatoxin production within the manure can occur. Since the manure is attractive to several species of ovipositing flies, notably Musca domestica, ample opportunity exists for the biotransfer of the aflatoxin from the manure into the insect larvae. Maggots can convert the manure substrate into their biomass with an efficiency of 71 per cent, after which the toxicity of the substrate increases. When this maggot-bioconcentrated crude aflatoxin was ingested by trout, severe aflatoxicosis was evident in the fish within 10 days. It is likely that, although trout would have little access to toxic maggots, the fish could receive carcinogenic doses via ingestion of the flies developed from toxic larvae. Based on the results of this study, it appears that serious environmental health problems could develop from the biotransfer and bioconcentration of aflatoxins originating in stockpiled manure. The problem is probably most prevalent in agricultural areas with favorable high temperatures and humidities. (Solid Waste Information Retrieval System)

## 2571 - A1, B1, F2 300

### LEGAL IMPLICATIONS OF FEEDLOT POLLUTION IN NEBRASKA,

Nebraska University-Lincoln College of Agriculture, The Agricultural Experiment Station

D. C. Nelson

Publication SB 529, Agricultural Experiment Station, University of Nebraska, Lincoln, 24 p.

Descriptors: Legal aspects, Feedlots, Nebraska, Nuisance, Negligence, Trespass, Common Law, Odor, Dust, Water pollution
Identifiers: Noise, Pests.

The common law and statutory legal implications of feedlot pollution in Nebraska are examined. The fundamental inquiry in Nebraska is to determine whether the feedlot operation violates the accepted rule of decency and substantially depreciates the value of the nearby property. The judicial precedents of such inquiry are discussed in terms of odor, dust, noise, water contamination and pests. The common law theories of nuisance, negligence and trespass are examined. Statutory measures are also discussed and suggestions are made for ways to reduce the chances of legal suits against feedlots due to pollution. (Penrod-East Central)

## 2572 - A1, B1, E1 400

### THE DRY DEEP PIT SYSTEM,

Purdue University

R. L. Adams

Poultry Tribune, Vol. 77, p. 26, 28, April, 1971. 2 fig.

Descriptors: Poultry, Odor, Water pollution, Ventilation
Identifiers: Deep pits, Flies.

Odors, flies, and nutrients in water courses are the typical pollution problems associated with poultry. All can be eliminated by use of a deep (8 to 10 ft.) pit under the poultry house if it is kept dry. Install and maintain a proper watering system. Mechanical ventilation will be required for high-density chicken populations. The pit may never require cleaning. (Whetstone, Parker, & Wells-Texas Tech)

## 2573 - A1, B1, F2 400

### A LIVESTOCKMAN'S GUIDE TO POLLUTION LAWS,

Special Feature Editor, Successful Farming

R. Lutz

Successful Farming, Vol. 70, p. 42-43, 50, October, 1972. 1 fig.

Descriptors: Legal aspects, Regulation, Feedlots, Water pollution, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin.

Laws are outlined for the states of Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Addresses of Agencies charged with supervision of agricultural pollution in the 12 states are included. (Whetstone, Parker, and Wells-Texas Tech)

**2574 - A1, E1, F2 600**

### METHODS AND PROBLEMS RELATING TO DISPOSAL OF WASTES FROM LIVESTOCK MARKETS,

H F Mayes

Presented at 66th Annual Meeting, American Society of Agricultural Engineers, University of Kentucky, Lexington, June 17-20, 1973, Paper No. 73-401, 11 p. 6 fig

Descriptors: Waste disposal, Livestock, Regulation, Design
Identifiers: Hydraulic cleaning, Sanitation requirements

Livestock markets have experienced problems in disposing of waste materials since the late 1940's. The two main species of livestock handled by most markets are cattle and swine. Design engineers need data on waste produced by each of these species. The amount of water used in hydraulic cleaning of wastes at market facilities is also needed. This data is essential if efficient waste treatment systems are to be designed for livestock markets. Research must supply this information since reference literature is not available. All of the market facilities are under the regulations of the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture and the respective State Veterinary's office. These animal health requirements specify daily cleaning of specific facilities. (Cartmell-East Central)

**2575 - A2, B2, E2 400**

### HE USES VALUABLE RUNOFF,

Successful Farming, Vol 73, No 8, p H10, June-July, 1975, 1 fig

Descriptors: Agricultural runoff, Drainage, Feed lots, Fertilizers, Costs
Identifiers: Waste collection, Land disposal

Bob Atherton's Earlville, Illinois feedlot has undergone a number of low-cost alterations over the years in order to eliminate muck and runoff problems on his cement feedlot. Atherton's feedlot is 86' x 110' with a capacity of 350-375 head of cattle. The lot has an 8-10" slope toward the middle. From here, liquids drain into a center outlet and buried tile and are carried to a 6' x 8' x 110' pit along the front of the lot. This pit collects nearly all the liquid runoff, including some loose manure. Atherton empties the pit about six times a year by means of a liquid spreader with a vacuum pump. A conventional loader handles the remaining solids. During winter months, Atherton tries to keep the pit about two-thirds full to prevent damage to the pit that might be caused by freezing and thawing if left empty. The system seems to work very well. A drier lot, drier bedding, and less required labor have resulted in an economic savings over Atherton's original system. Final alterations for this lot cost $2,500, only about $7 per head capacity. (Cameron-East Central)

**2576 - A4 300**

### POLLUTED GROUNDWATER: A REVIEW OF THE SIGNIFICANT LITERATURE,

TEMPO, General Electric Company Center for Advanced Studies, Santa Barbara, California
D. K. Todd and D. E. McNulty
Environmental Protection Agency Report Number EPA-600-4-001, March, 1974, 215 p. 661 ref.

Descriptors: Groundwater pollution, Bibliographies, Water pollution sources, Underground waste disposal, Aquifer Management, Waste disposal wells, Saline water intrusion, Path of pollutants.

A selective review is presented of the literature on man-caused groundwater pollution, including causes and occurrence, procedures for control, and methods for monitoring. No attempt was made to develop a comprehensive bibliography on the subject. Rather, references were selected for inclusion on the basis of their significance and relevance. Bibliographies, important general references, abstracts, and European references are discussed separately. Thereafter the literature is described in essay form on a subject basis. References cited by number in the text are listed in complete bibliographic form at the end of the report together with an author index. With few exceptions, the material reviewed is limited to relatively recent published items in the United States. Administrative regulations, legal reports, and unpublished materials such as theses have been omitted. (Environmental Protection Agency)

**2577 - A1, E2 700**

### RATE AND EXTENT OF NITROGEN AND PHOSPHORUS MOVEMENT THROUGH GLACIALLY DEPOSITIED SOILS TREATED WITH POULTRY MANURE,

R. A. Hoffman

MS Thesis, Department of Agronomy, University of Maine, Orono, June, 1973, 160 p. 9 fig. 42 tab. 111 ref.

Descriptors: Nitrogen, Phosphorus, Soils, Infiltration, Poultry
Identifiers: Land disposal

The objective of this study was to monitor the movement of ammonium, nitrate and phosphate ions in the soil water solution as influenced by the incorporation of poultry manure into the plow layer. Soil samples were collected for analysis of selected chemical properties. There was some variability in the results because of missing samples and seasonal fluctuations. Provided available soil moisture was present and the vacuum was applied within 48 hours prior to water sample collection, the porous ceramic cup technique was an adequate means of extracting soil water from a soil profile. The soil water solution collected increased in $NH_4$-N and $NO_2$-$NO_3$-N concentration, presumably due to the manure applied. The level of $NH_4$-N, $NO_2$-$NO_3$-N and $PO_4$-P in the ground water table in the Windsor loamy sand was not significantly increased by manure applications during the study period. There was a significant increase in the $NH_4$-N and $NO_2$-$NO_3$-N concentration on top of the fragipan within the treatment plots on the Charlton fine sandy loam. During the study the total soil nitrogen and the organic matter analyses indicated little change resulting from manure application. (Penrod-East Central)

**2578 - A1, E2 700**

### NITROGEN TRANSFORMATION AND MOVEMENT IN A MARINE SEDIMENT SOIL FOLLOWING TREATMENT WITH VARYING RATES OF POULTRY MANURE,

R. F. Jeffrey

MS Thesis, Department of Agronomy, University of Maine, June, 1972, 124 p. 17 fig, 29 tab, 84 ref

Descriptors: Poultry, Leachates, pH
Identifiers: Nitrogen transformation, Nitrogen movement, Marine sediment soil, Land disposal, Application rates.

The purpose of this study was to determine the transformations and movement of nitrogen through a marine sediment soil following application of poultry manure at rates of 0, 200, 400, 800, and 1600 pounds of nitrogen per acre per year. A Scantic soil was treated three times over a nine-month period with five levels of nitrogen in the form of poultry manure. The resulting leachate and soil were analyzed for selected microbiological and chemical properties. Soil microorganisms, Nitrosomonas, Nitrobacter, and the denitrifiers tended to increase under all treated plots in comparison to the control. The population levels for the two nitrifiers were greatest in the A horizon while the denitrifiers were greatest in the B horizon. Greater than 90 per cent of the original or applied nitrogen was accounted for upon evaluation of all incoming and outgoing sources of nitrogen. The greatest treatment, 1600 pounds nitrogen per acre per year, lost the greatest amount. In the A horizon, total soil nitrogen increased as treatment rate increased. Also as treatment of nitrogen increased, the easily oxidizable organic matter showed an increase in the upper two horizons. Under the two highest treatments, 800 and 1600 pounds of nitrogen per acre, a considerable decrease in pH took place at all depths. (Penrod-East Central)

**2579 - C1, D1 100**

### MICROBIOLOGY IN THE AEROBIC TREATMENT OF FARM WASTES,

J. M. Grainger

Process Biochemistry, Vol 8, No. 3, p. 26-30, March 1973, 28 ref.

Descriptors: Microbiology, Aerobic treatment, Research and development, Sampling, Microorganisms, Design, Waste treatment

Microbiology is making an increasing contribution to research work on farm waste problems in relation to treatment systems and the consequences of disposal of treated and untreated slurry to land. A necessary contribution is the study of factors which influence growth and activities of microorganisms, the results of which can be valuable in designing and operating treatment systems. It is essential that studies be done with cultures that are adequately representative of those microorganisms whose activities are important in the treatment process. Consequently this article examines some procedures for the enumeration and isolation of heterotrophic microorganisms, of aerobic systems for treatment of farm slurry. The projects being studied concern cattle slurry treatment by an oxidation ditch, treatment of poultry manure by a biological filter, and the disposal of heavy dressings of cattle slurry to grassland. The microscope may be used for observing the colony and its isolates. Accurate isolation of bacteria representative of that in the treatment system is dependent on (a) handling of sample before examination in the laboratory, (b) dilution and homogenization, (c) composition of isolation medium, (d) method of inoculating the isolation medium, and (e) temperature and period of incubation. Each of these procedures is examined in detail. (Merryman-East Central)

**2580 - A1, B1, C1, D4, E2 100**

### THE TREATMENT OF LIVESTOCK WASTES,

Scottish Farm Buildings Investigation Unit, Aberdeen
A. M. Robertson
Process Biochemistry, Vol 7, p. 21-25, June 1972, 7 fig, 6 tab, 7 ref.

Descriptors: Livestock, Waste treatment, Feedlots, Confinement pens, Physical properties, Chemical properties
Identifiers: Land disposal, Scotland, Loading rates, Oxidation ditch, Anaerobic lagoons, Liquids solids separation, Surface aerator.

Because in the future livestock will be produced in feedlots and confinement pens of increasing size, increased technology and knowledge will be needed for animal waste management. Factors influencing animal waste properties are species, feeding, environment, and liveweight. While land disposal is still a desired means of animal waste disposal, overfertilization due to excessive nutrients in the soil is making researchers take a long hard look at land disposal. Land spreading should be avoided when soil temperatures are less than 4.4 degrees C. Spreading rate should at times be lower than the instantaneous infiltration capacity of the soils and should never be so heavy that it forms an impermeable cap. Maximum amounts to be spread should be determined by permissible hydraulic and chemical soil loading rates. In addition, it may be necessary to improve waste handling qualities before land disposal through biological treatment. Examples of such treatment may be found in the examination of Aberdeen's experiment utilizing oxidation ditches, surface aerators, and anaerobic lagoons. A theoretical assessment of the variety application of the waste treatment systems described is given along with suggested theoretical relationships between investment costs in the treatment plant, etc., and the level of treatment achieved. (Merryman-East Central)

### 2581 - D4 100

### ANAEROBIC DIGESTION OF HOG WASTES,

Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa
E P Taiganides, E R Baumann, H F Johnson, & T E Hazen
Journal of Agricultural Engineering Research, Vol 8, No 4, p 327-333, 1963. 5 fig, 9 ref.

Descriptors: Anaerobic digestion, Sludge digestion, Methane, Carbon dioxide, Nitrogen, Design criteria.
Identifiers: Swine, Detention period, Volatile solids, Gas yield, Fertilizer value.

From the viewpoint of aesthetics, economics and public health, farm wastes should be given a treatment that will stabilize the manure, remove its nuisance characteristics, sustain its fertilizer value and reduce the pollution properties of the manure to a safe level before final disposal. Although there are a number of such treatments, the objective of this study was to examine the anaerobic sludge digestion process and report the results of a laboratory study on the application of sludge digestion for the treatment of swine wastes. The laboratory study showed that at 95 degrees F, hog wastes were digested satisfactorily at a daily volatile solids loading rate of 0 20 lb-ft$^3$ and a detention period of less than ten days. This showed that 1 ft$^3$ of digester volume is required for each pig produced within one year. A range of 7 8 to 10 3 ft$^3$ was the average gas yield per day per pound of volatile solids fed. Gas content was approximately 58 per cent methane, 40 per cent $CO_2$, with most of the remaining gas being free nitrogen. Based on research data and a average hog manure composition, about 3000 B t u -day can be produced from the daily wastes of a pig. Digested manure characteristics were greatly improved through digestion. Also digestion reduced the organic matter of the raw manure and, thus, its potential pollutional strength by 60-70 per cent. Digester design and cost considerations are also discussed. (Penrod-East Central)

### 2582 - A1, E3 100

### THE LONG TERM MANAGEMENT OF ANIMAL MANURES,

Department of Agricultural Engineering, University of Newcastle upon Tyne
J R O'Callaghan, V A Dodd, and K A Pollock
Journal of Agricultural Engineering Research, Vol 18, p 1-12, 1973. 3 fig, 5 tab, 24 ref.

Descriptors: Nutrients, Odor, Water pollution, Crop response.
Identifiers: Land disposal, Application rates, United Kingdom.

Disposal problems have caused some farmers to resort to spreading manures on land at what could be considered as "dumping" rates of application. The purpose of this study is to examine the second order effects of indiscriminate dumping of animal waste and to provide guidelines for the rationalization of the management and disposal of manure by land spreading. Manure management is discussed in terms of a model, based on the mass balance of nutrients within a control area. In the steady state, application rate must be balanced by removal rate. This model takes into account imports of nutrients in the form of chemical fertilizers and feedstuffs. Animal manures can be utilized with chemical fertilizers for crop production with considerable benefit. Because excess nutrients are a pollution hazard and because land disposal often is accompanied by an odor problem, some form of treatment of manures prior to land disposal may be necessary. Consequently, more research needs to be done in these areas. (Penrod-East Central)

### 2583 - A1, B1 700

### CLOSED CONFINEMENT BEEF BUILDING CALORIMETRY AND INFLUENCES OF THE MANURE STORAGE TANK,

P G Remmele
MS Thesis, South Dakota State University, Brookings, May, 1973. 83 p. 15 fig, 6 tab, 40 ref.

Descriptors: Confinement pens, Cattle, Storage tank, Latent heat, Ventilation.
Identifiers: Calorimetry, Heat production, Moisture production, Dry bulb temperature.

To successfully design a confinement livestock ventilation system, heat and moisture production data are necessary. The objective of this study was to determine the heat and moisture produced under actual conditions from a closed confinement beef building housing 47 Hereford steers, to determine the heat and moisture contributions to the environment from the manure storage tank located under the slotted floor, and to determine sensible and latent heat production from a closed confinement building. The study was done at the Farmer's Union Grain Terminal Association's modern and well designed beef research facility near Sioux Falls, South Dakota. The average daily total heat production of the building ranged from 1530 to 4070 Btu/hr/head and averaged 2870 Btu/hr/head. The sensible heat production of the building was generally negative above inlet dry bulb temperatures of 70 degrees F and building latent heat production increased for inlet dry bulb temperatures above 60 degrees F. Sensible heat production from the manure storage tank was inversely related to animal density. The removal of sensible heat from and the addition of latent heat to the animal area of the building was the overall effect of the manure storage tank. Significant prediction equations were determined for latent, sensible and total heat production of the building and building corrected for manure storage tank contributions and for sensible heat production of the manure storage tank. (Penrod-East Central)

### 2584 - A4, D4, E2 700

### MINIMAL TREATMENT OF SWINE MANURE FOR IRRIGATION: EFFECT ON NITROGEN,

A M A Shady
MS Thesis, Department of Agricultural Engineering, McGill University, Montreal, Quebec, Canada, May, 1973. 124 p. 19 fig, 20 tab, 37 ref.

Descriptors: Aerobic treatment, Nitrogen compounds, Irrigation, Effluent.
Identifiers: Swine, Groundwater pollution, Soil column, Leachate analysis, Nitrogen removal.

Continuous-flow aerobic treatment was applied to swine manure as a minimal treatment. The various levels of different nitrogen compounds were studied to determine the reduction of such compounds. Short-term aeration was found to reduce nitrogen content by as much as 46 per cent. Most of the nitrogen losses were as free ammonia stripped out of the reactor. Nitrate formation was very low due to limited oxygen supply. Changes in flow rate and/or detention time did not affect the amount of reduction of total Kjeldahl nitrogen or ammonium. The manure was applied in one application of one inch, two applications of one-half inch at 18 day intervals, and four applications of one-fourth inch at nine day intervals. Treatment applications of one inch gave the highest value of recovered nitrogen, which leads to the conclusion that the more waste added in one application the more immediate the effect; however, odor was most offensive in this application, even though previous aerobic treatment eliminated much of the odor. From this evidence it appears that applying the same amounts of nitrogen to the soil column in different applications will dilute the effect and spread it over a longer period. (Sanders-East Central)

### 2585 - A1 100

### POLLUTION EFFECTS ON SURFACE AND GROUND WATERS,

Department of Civil Engineering, Hawaii, Honolulu
R H F Young
Journal Water Pollution Control Federation, Vol 46, No 6, p 1419-1429, June, 1974. 103 ref.

Descriptors: Water pollution sources, Nutrients, Heavy metals, Chemicals, Runoff.
Identifiers: Ground water pollution, Agricultural wastes, Radionuclides, Biological contamination, Soil contamination.

This report reviews literature concerning the pollution effects of various substances on surface and groundwater. Among the substances covered are: nutrients, agricultural wastes, chemicals, heavy metals and radionuclides, and biological contamination. Nutrient enrichment sources cited were sewage treatment effluents, industrial wastes, urban runoff, and agricultural runoff. Documented sources of agricultural pollution were: (1) percolates from surface irrigated dairy manure slurries, (2) storm runoff from cattle feedlots, (3) runoff from agricultural watersheds, and (4) seepage from wastewater irrigation. Chemical pollution sources cited were: oil field brine disposal; salt-water intrusion in coastal areas; irrigation-return flow; contaminants from outboard motor fuel; herbicides; use of deicing salts on highways; and the mobilization of the constituents in contaminated snow, such as heavy metals, oils, greases, phenols, and BOD from decaying organic matter. Heavy metal and radionuclide contamination sources that were discussed were discharges from gold recovery operations, use of nuclear reactors, and nuclear weapons tests. Sources of biological contamination that were cited included: (1) slime outbreaks due to industrial or domestic wastewater effluents, (2) coliforms due to discharges from boats and a faulty septic tank, and (3) viruses from septage filtrates. Reclamation by groundwater recharge, soil pollution, and modeling and analytical research methods were also reviewed. (Penrod-East Central)

### 2586 - A6, A9, B1, E2 200

### AIRBORNE HEALTH HAZARDS GENERATED WHILE TREATING AND LAND DISPOSING WASTE,

Department of Agricultural Engineering, University of Minnesota, St. Paul, Minnesota 55108
P R Goodrich, S L Diesch, and L D Jacobson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 7-10.

Descriptors: Bacteria, Microorganisms, Air pollution, Health, Sampling, Waste treatment, Wind velocity.
Identifiers: Land disposal, Oxidation ditch, Wind direction, Spray disposal, Fecal coliforms, Fecal Streptococci.

Airborne microorganisms were monitored in several animal housing facilities. They were also monitored during spray disposal applications using irrigation equipment. All glass impingers were used for sampling. The all glass impinger (AGI) is designed to simulate the human respiratory system with respect to sampling rate (12.5 liters per minute) and particle size retention (1-10 microns). The AGI uses a vacuum to draw the air sample into a collecting fluid for scrubbing and then, through a critical orifice for volume measurement. Bacterial plate techniques were used to identify total bacteria, fecal coliforms and fecal Streptococci per liter of sampled air. The field sampling during waste disposal operation resulted in erratic information, due largely to the uncontrolled nature of the events. However, elevated levels of bioaerosols are definitely generated in the spray disposal process. These are carried beyond the wetted area and have the potential to travel many miles before settling. Care in selecting proper wind speed and direction conditions is needed. The results from Beef and Dairy barn sampling at three levels show that the oxidation ditch itself does not increase the hazard to man or animals in the housing environment or the nearby exterior environment. However, certain activities, such as cleaning, sweeping and facilities repair caused conditions hazardous to human respiratory system. Protective masks were indicated for persons engaged in these tasks. Higher counts were associated with the presence of animals in the facility and the relative activity of the animal. (Goodrich, et al-University of Minnesota)

### 2587 - A9, B2 200
### SURVIVAL OF SALMONELLAE, TOTAL COLIFORMS AND FECAL COLIFORMS IN SWINE WASTE LAGOON EFFLUENTS,

Department of Microbiology, Clemson University, Clemson, South Carolina
D. J. Krieger, J. H. Bond, and C. L. Barth
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 11-14

Descriptors: Salmonellae, Lagoons
Identifiers: Fecal coliforms, Swine, Survival

A study was undertaken to determine the survival characteristics of *Salmonella cholerae-suis*, *Salmonella typhimurium*, total coliforms and fecal coliforms in swine waste lagoon materials. Columns of swine waste lagoon material were loaded with various population densities of S. cholerae-suis and S. typhimurium. Enumeration of total and fecal coliforms employed MPN methods utilizing lactose broth and EC medium, respectively. Enumeration of Salmonella was determined by MPN methods using Tetrathionate Broth, and confirmed by plating on Brilliant Green agar and agglutination with Salmonella O antiserum poly A-I. Initial population counts of 2.5 x $10^5$ organisms-ml of *S. cholerae-suis* and 7 x $10^4$ organisms-ml of *S. typhimurium* decreased to non-recoverable levels in 28 days. Initial natural populations of 20 organisms/ml of fecal coliforms showed complete die-off after 10 days, and natural populations of 3.3 x $10^3$ organisms-ml of total coliforms died off in 21 days. Survival times were also determined in columns which were loaded with high and low initial Salmonella populations. In all cases, the survival time of the organisms observed was determined by the initial numbers, whereas, the death rate of Salmonella was independent of the numbers in the original population. Efforts to recover bacteriophage from lagoon materials and loaded columns against coliforms and Salmonella were negative. Antagonisms were not responsible for die-off rates. Results indicated that depletion of an essential growth factor was probably the cause of death. (Krieger, et al-Clemson University)

### 2588 - A8, B2, D3 200
### MOSQUITO PRODUCTION AND CONTROL IN ANIMAL WASTE LAGOONS,

Department of Entomology, North Carolina State University, Raleigh, North Carolina 27607
R. C. Axtell, D. A. Rutz, M. R. Overcash, and F. J. Humenik
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 15-18

Descriptors: Mosquitoes, Lagoons, Insecticides, Simulation analysis
Identifiers: Mosquito control, Swine

Simulated waste lagoons (55 gal. drums) were operated for 6 months at different manure loading rates, which resulted in several organic pollution levels, and the numbers of mosquito larvae and pupae were determined weekly. The abundance of mosquitoes (mostly *Culex quinquefasciatus*) was correlated with the degree of pollution (measured as COD and TOC). With swine waste, mosquito production was optimal at about 320 cu. ft. of lagoon volume per 100 lb. hog with very little production at and below 80 cu. ft. per hog and at or above 1280 cu. ft. per hog. Similar mosquito production data for poultry waste loading rates are given. Also, mosquito production versus degree of pollution was determined weekly for 6 months at 5 on-farm operating swine lagoons. The effectiveness for mosquito control in simulated lagoons and in on-farm swine lagoons was determined for the following insecticides: malathion, chloropyrifos, Abate and Flit MLO. Also, the insect growth regulators TH6040 and Altosid were evaluated. No impaired lagoon performance was evident with the addition of these chemicals at the dosage rates used. The numbers of mosquito larvae were determined by a standard dipping method at frequent intervals before and after treatment. Mosquito control was obtained for periods of 7 days to 2 months depending upon the chemical and dosage rate. (Axtell, et al-North Carolina State University)

### 2589 - A9, B1 200
### PATHOGENIC MICROORGANISMS IN THE ENVIRONMENT,

Veterinary Services, Animal and Plant Health Inspection Service, Agricultural Research Center East, Beltsville, Maryland 20705
G. B. Van Ness
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 19-21

Descriptors: Pathogenic bacteria, Animal wastes, Livestock, Health, Water pollution
Identifiers: Parasites

Infectious diseases of livestock which are spread through manure and urine are the problems of herd management, unless the infectious agent also survives in the environment, and becomes a pollutant of other premises. Experience suggests spread to other premises depends on biological properties inherent in the pathogenic organisms. In pollution control, there is need to give attention to some organisms, while others may be of little concern. Pathogens which can grow and multiply in the environment are very important pollutants. Some pathogens persist in the environment. Some virus pathogens are able to survive longer in the environment than do others, and can be dangerous water pollutants. Current information is gathered regarding the differences, as a guide to further epidemiological and laboratory studies of polluting organisms. (Van Ness--Agricultural Research Center East, Beltsville, Maryland)

### 2590 - B1, D1, E2, E3, 200
### ENGINEERING AND ECONOMIC OVERVIEW OF ALTERNATIVE LIVESTOCK WASTE UTILIZATION TECHNIQUES,

Departments of Agricultural Engineering and Economics, Colorado State University, Fort Collins, Colorado 80523
J. M. Harper and D. W. Seckler
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 22-25

Descriptors: Economics, Recycling, Energy, Methane, Fertilizer
Identifiers: Manure, Wastelage, Refeeding, Pyrolysis, Land spreading

Beef manure may be utilized as follows: (1) Refeeding—dried manure, wastelage, fractionated manure, and fermented manure, (2) Energy—Anaerobic fermentation-methane, Anaerobic fermentation-some methane with refeeding of biomass, pyrolysis, (3) Fertilizers—land spreading (dry), land spreading (irrigation). To compare these alternatives accurately, an engineering evaluation of the capital requirements and operating costs associated with each alternative is developed using a 10,000 head confinement feedlot as the basis of comparison. Common to all these systems is a manure collection system. Each then requires various additional capital costs to allow utilization in the manners outlined. An economic analysis was run using the capital and operating cost estimates to determine the production costs of the products of each of the utilization methods. These production costs were then compared to current and projected prices for feed, energy and fertilizer to determine the economic viability of the alternatives. It appears that processes producing refeedable products show considerable economic potential. Unless anaerobic fermentation processes can be sped up, thereby reducing capital requirements and the value of methane increases substantially, methane production appears to be a poor alternative to refeeding manure as a method of utilization. Utilization of manure as fertilizer depends extensively on circumstances such as distance and availability of disposal sites. Costs increase rapidly as distances increase. (Harper & Seckler-Colorado State University; Merryman, ed.)

### 2591 - B1, D4, E3 200
### AN ECONOMIC ANALYSIS OF METHANE GENERATION FEASIBILITY ON COMMERCIAL EGG FARMS,

Department of Agricultural and Food Economics, University of Massachusetts, Amherst
T. C. Slane, R. L. Christensen, C. E. Willis, and R. G. Light
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 26-29

Descriptors: Methane, Feasibility studies, Poultry, Economics, Costs, Energy

The study focused on determination of net costs associated with adoption of a methane generation system by commercial egg production units of 20,000, 40,000 and 80,000 birds in a cage housing system. Only costs and returns attributable to the methane generating system were considered. A model methane generation system was developed that satisfied the technical requirements for the anaerobic process. The system was specified in terms of size and operating characteristics as determined by the waste production of each flock size. Daily loading of the digester was assumed. The methane generated was used to fuel an engine-generator(s). The engine-generator was assumed to run continuously and provide supplementary electrical power. Specifically, the electricity generated would be sufficient to fulfill the requirements for lighting and ventilating fans in the production operation as well as those associated with operation of the digester itself. Thus, the primary or commercial power sources could be considered as "stand by" for those electrical requirements. The fixed and variable costs of the system were estimated for the three benchmaker operations by identifying the fixed and variable factors associated with the system, estimating input requirements, and budgeting costs for each unit. The results indicate that the system studied was not economically feasible at present. This conclusion is directly related to the assumed cost of commercial power. For the smallest flock size a commercial electrical cost of nearly 10 cents per kilowatt-hour would be a "breakeven" while for the largest size the "breakeven" is about 6 cents per kilowatt-hour. It is conceivable that commercial electricity prices might reach such levels within the next decade. (Slane, et al-University of Massachusetts; Merryman, ed.)

## 2592 - A1, E2, F1 200

### ECONOMICS OF SUBSTITUTION AND THE DEMAND FOR BEEF FEEDLOT WASTES: ONE ALTERNATIVE FOR SOLVING ENVIRONMENTAL QUALITY PROBLEMS,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 30-32.

Descriptors: Economics, Fertilizers, Feedlots, Cattle
Identifiers: Manure, Environmental quality.

Three years ago, when manufactured fertilizer was abundant and prices were relatively low, it was increasingly difficult to convince farmers to buy and use manure on their cropland. Since 1972, crop producers have been encouraged to plant all acres that previously were in set-aside programs. Demand for fertilizers to bring these 40 million acres of land back into production, as well as price controls imposed on domestic fertilizer prices in 1972 and early 1973, caused fertilizer shortages. Lifting of the price controls in 1973 caused sky-rocketing prices for fertilizers. Consequently, alternative nutrient sources for crop lands have been in demand. Thus, cropland farmers have been willing to pay for beef feedlot wastes, as well as for higher transportation costs. A survey of 60 beef cattle feedlots in the Oklahoma and Texas panhandle is underway to determine the supply and demand situation for beef feedlot wastes and resulting environmental quality implications. (Badger-Oklahoma State University; Merryman, ed.)

## 2593 - A1, B1, D1, E1, F1, 200

### ECONOMIC RESEARCH PERTAINING TO PROBLEMS OF LIVESTOCK WASTE MANAGEMENT AND POLLUTION CONTROL,

Department of Agricultural Economics, Michigan State University, East Lansing
L. J. Connor and J. B. Johnson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 33-36.

Descriptors: Livestock.
Identifiers: Economic research, Waste management, Pollution control, Literature review, State of the art.

This paper presents a literature review on the state of the art in the economic analysis of livestock waste management and pollution control problems, a discussion of major economic research findings, and suggestions for future research. Past economic research pertaining to problems of livestock waste management and pollution control are summarized by the following categories: (1) least-cost livestock waste management systems; (2) industry structure studies pertaining to the distribution of firms by size, housing type, and waste management system; (3) nonmarket control measures for effectuating pollution control; (4) economic impact studies (static and dynamic) of nonmarket control measures; (5) economic analyses of recycling animal waste; (6) energy costs associated with alternative waste management systems; and (7) miscellaneous studies. Research studies on these problems are appraised relative to the major conclusions which can be drawn, inconsistencies in major conclusions and methodologies employed in the research studies reviewed, and apparent research voids. The impacts of alternative pollution control measures are analyzed with respect to the likely effects upon individual livestock producers, the size and technology distribution of livestock production units within each industry, consumer prices, and implications for pollution control agencies. Conclusions relative to least-cost waste management systems (with and without pollution control measures assumed) are drawn wherever data are available. Research voids and areas where various research studies show conflicting results are noted. (Connor & Johnson-East Lansing; Merryman, ed.)

## 2594 - A1, B1, E1, F1 200

### ECONOMICS OF ALTERNATIVE BEEF WASTE MANAGEMENT SYSTEMS,

Department of Agricultural Economics, Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln
M. Baker
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 37-40.

Descriptors: Economics, Cattle, Feedlots, Confinement pens.
Identifiers: Waste management.

Livestock producers who are installing waste management systems want to know the least cost system that will meet EPA and state pollution regulations. Three waste management systems for unpaved feedlots and three systems for confined feeding facilities were studied in Nebraska. Initial investment and operating costs of disposal systems were included in the study. This provides a total picture of cost of handling waste associated with beef cattle feeding. Data were obtained from owners and operators of operational systems on initial investment, amount of materials required and disposal systems to be used. Costs for disposal equipment were obtained from manufacturers, dealers and suppliers of this equipment. Recognition of microbial decomposition on the feedlots was included in the study. Initial investment in beef feedlot waste management systems is substantial and provides no additional revenues to the feeder. Annual operating costs are minimal; however, even this represents an increased cost of feeding cattle. With a large fixed investment, there are considerable reductions in cost per head capacity as the size of feedlot increases, but most of these reductions are realized by feedlots with capacities of approximately 500 head. Thus, the annual cost per head for extremely large management systems for confined feeding facilities are considerably more expensive to construct than are those for unpaved feedlots. This largely reflects the additional materials required for such systems. (Baker-University of Nebraska; Merryman, ed.)

## 2595 - B1, F1, F2 200

### ECONOMIC IMPACTS OF ALTERNATIVE WATER POLLUTION CONTROL RULES ON BEEF FEEDLOTS OF LESS THAN 1000 HEAD CAPACITY,

Department of Agricultural Economics, Ohio State University
D. L. Forster, L. J. Connor, and J. B. Johnson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 41-44.

Descriptors: Legislation, Water pollution control, Feedlots, Cattle, Economic impact, Agricultural runoff.
Identifiers: Environmental Protection Agency.

Estimates are made of the economic impacts of four alternative water pollution rules on the behavior of beef feedlots over the 1975-1985 period. The four alternative water pollution control rules applied to beef feedlots of all capacity levels were: (1) current EPA guidelines requiring control of feedlot runoff from the local 10-year, 24-hour rainfall and process generated waste waters by 1977 and runoff from the local 25-year, 24-hour rainfall and process generated waste waters by 1983; (2) the construction of control facilities for control of the local 25-year, 24-hour storm and process generated waste waters by 1983; (3) the control of all runoff from rainfall occurring in any six-month interval by 1977; and (4) the control of all runoff from rainfall occurring in a six-month interval and no winter spreading of feedlot solid wastes. A simulation model was used to represent the production behavior of beef feedlots typical of the Lake States and Corn Belt over the 1975-1985 period. Imposition of rule 1 on feedlots of less than 1,000 head would result in an average feedlot firm equity loss of $3,720 over the 1975-1985 period. Rule 2 would result in average equity loss of $3,911 over the 1975-1985 period. Rule 3 would result in average equity loss of $4,800 per feedlot. Rule 4 would result in an average equity loss of nearly $6,000 per feedlot over the 1975-85 period. The decline in marketings would range from one-half to one per cent under the four rules over the 1975-1985 period, resulting in only nominal price increases for fed beef. Economic effects at the feedlot level would not be uniform, placing the greatest burden on the smaller feedlots. (Forster, et. al.-Ohio State University; Merryman, ed.)

## 2596 - B1, F1, F2 200

### EFFECTS ON ENVIRONMENTAL LEGISLATION ON CATTLE FEEDLOT LOCATION,

Industrial and Systems Engineering, Ohio State University, Columbus
D. L. Byrkett, E. P. Taiganides, and R. A. Miller
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 45-48.

Descriptors: Model studies, Locating, Costs, Economics
Identifers: Federal Water Pollution Control Act Amendments of 1972, Cattle feeding.

The paper discusses the development of a cost minimization linear programming model which was used to study the effect of the 1972 Federal Water Pollution Control Act Amendments on the location of cattle feeding in the continental United States. Factors affecting feedlot location which were included in the model are feeder grain and roughage availability; slaughter capacity, demand requirements, nonfeed costs, and transportation costs. The United States was divided into sixteen cattle feeding regions; all data were developed for the year 1972. This model has two unique features. One is the separate definition of regions for cattle feeding, feeders, grain, roughage, slaughter, and demand. The other is that the model considers the competition between cattle feeding and other uses for available land. This competition is modelled by increasing nonfeed costs as production in a given region increases. In regions where competition for available land is great, nonfeed costs increase more rapidly; nonfeed costs increase less rapidly where competition is small. The model was then used to determine the minimum cost equilibrium location of cattle feeding. These results indicated continued growth in the southern plains and continued declines in the corn belt, eastern United States, and California. To model the effect of the Federal Water Pollution Control Act Amendments of 1972, the nonfeed costs were adjusted to describe the impact of this legislation on each cattle feeding region. Equilibrium locations were then calculated using the adjusted nonfeed costs and were compared with the equilibrium locations calculated without the legislation in effect. (Byrkett, et. al.-Ohio State University)

**2597 - A2, B1, F1, F2 200**

### ECONOMIC IMPACTS OF IMPLEMENTING EPA WATER POLLUTION CONTROL RULES ON THE UNITED STATES BEEF FEEDING INDUSTRY,

Agricultural Economists, Economic Research Service, USDA, East Lansing, Michigan
J. B. Johnson and G. A. Davis
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 49-52.

Descriptors: Economic impact, Feedlots, Agricultural runoff, Effluent.
Identifiers: Federal Water Pollution Control Act Amendments of 1972, Environmental Protection Agency, Point source discharges.

The Federal Water Pollution Control Act Amendments of 1972 provide a mandate for the EPA to achieve improvements in the quality of navigable waters. EPA announced effluent limitations for beef feedlots in February, 1974. By July 1, 1977, feedlots with point source discharges will be required to have in use the "best practicable control technology currently available." The guidelines require no discharge of waste waters from feedlots except those in excess of control systems designed to accommodate runoff from local 10-year, 24-hour rainfalls and process generated waste waters. These guidelines are to be administered through National Pollutant Discharge Elimination System permits for beef feedlots of 1,000 head or more capacity. (However, beef feedlots of smaller capacity may be expected to comply through NPDES or State permit programs.) The objectives of this paper are: (1) to estimate the number of beef feedlots which could be subject to effluent guidelines and (2) to estimate the economic impacts on the beef feeding industry. It is estimated that an additional $133 million capital outlay would be necessary to allow the 49,000 beef feedlots of all capacity levels with problems to be in compliance with EPA rules by 1977. This level of industry investment would be needed to provide feedlots with control systems consisting of diversion terraces, a settling basin, a retention pond, and pump irrigation equipment for distributing runoff to farmland. As things now stand, 95 per cent of the investment would be imposed on feedlots with less than 1,000 head capacity. Investments could range from $8 to over $100 per head for feedlots of less than 1,000 head capacity adopting runoff control systems. For larger feedlots, per head investment would average $1.40 to $3.20 per head. (Johnson and Davis-USDA; Merryman, ed.)

**2598 - A3, B1, F1 200**

### ECONOMIC AND ENVIRONMENTAL ASPECTS OF DAILY AND ANNUAL DAIRY MANURE SPREADING SYSTEMS IN A SMALL WATERSHED,

Pennsylvania State University Extension Service, Reading, Pennsylvania
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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 53-56.

Descriptors: Economics, Dairy industry, Watersheds, New York, Model studies, Nitrogen, Phosphorus.
Identifiers: Land spreading, Soil loss.

This paper reports the simulated nitrogen, phosphorus and soil loss from a 7,000 acre watershed where daily manure spreading is practiced. It also reports the simulated results when the system is changed to 12 months storage combined with direct incorporation of manure within 24 hours. The simulated nitrogen, phosphorus and soil losses from the two systems are incorporated into an analysis to determine the economic and environmental impact of controlling nutrients losses from the watershed under various policies. The physical model was constructed from published laboratory and field data and had sub-components for soil moisture, soil temperature, soil movement, nitrogen and phosphorus. The basic economic model was structured to be representative of the kinds, amounts and intensities of agriculture found by survey in a small central New York watershed. The modeling suggests that farm costs of reducing nutrient losses to water are substantial. In addition to the loss of nutrients to water, there are other environmental factors, such as odor, flies and appearance, to consider when evaluating dairy manure handling systems. A summary of the cost and environmental impact, which is a combination of 7 environmental characteristics, of alternative dairy manure handling systems is included. Above results indicate that manure handling systems need to be carefully evaluated for their economic and environmental impact. (Schaffer-Pennsylvania State University Extension Service; Merryman, ed.)

**2599 - A1, B1, F2 200**

### IMPLICATIONS OF SELECTED NON-POINT SOURCE POLLUTION REGULATIONS FOR U.S. DAIRY FARMS,

Agricultural Economist, USDA, University of Minnesota
B. M. Buxton and S. J. Ziegler
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 57-60.

Descriptors: Legal aspects, Dairy industry, Costs, Waste storage.
Identifiers: Non-point Source Pollution Control Regulations, Land disposal.

Federal regulations governing the land disposal of animal wastes may be forthcoming. Some states have enacted regulations or guidelines which restrict manure disposal. This study focuses on possible non-point source pollution control regulations; the number of U.S. dairy farmers affected by alternative disposal restrictions; and, where applicable, the costs of compliance with these regulations. Alternative non-point regulations are selected from existing or proposed state guidelines and these regulations are imposed on U.S. Dairy farms. The following criteria are considered: restricting dairy cows, animal units, manure tonnage, and nitrogen applied per acre, and manure disposal on rolling or steeply sloping ground. The number and proportion of producers exceeding alternative restrictions are estimated based on a recent survey of U.S. dairy producers. The number of producers in the northern United States who spread manure during winter months are estimated and the aggregate cost of manure storage calculated. In addition, the location of individual U.S. dairy farms with respect to the nearest farm residence, nearest community, and public recreational area is estimated. (Buxton and Ziegler-University of Minnesota)

**2600 - A1, B1, D1, E1, F2 200**

### FEEDLOT EFFLUENT LIMITATIONS BASED UPON EXEMPLARY OPERATIONS,

Chief, Impact Analysis Section, Technical Analysis and Information Branch, Effluent Guidelines Division, Environmental Protection Agency, 401 M Street, S. W., Washington, D.C.
J. D. Denit
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 61-63.

Descriptors: Legislation, Feedlots, Water pollution, Effluent, Poultry, Costs, Geography, Climates.
Identifiers: Pollution control, Federal Water Pollution Control Act.

As one of the specifically enumerated industrial point sources of pollution, feedlots are required to comply with certain pollution control standards as stipulated in Sections 301, 304, and 306 of the Federal Water Pollution Control Act, as amended, 1972, (The Act). In response to requirements in the Sections, a regulation which sets forth the specific effluent limitations for feedlots was promulgated on February 14, 1974. The substance of the limitations thus established was "no discharge of pollutants to navigable water." Subject to an exception for discharges due to unusual rainfall conditions. The limitations impact existing feedlots with effluent limitations for 1977 and 1983, and new feedlot sources (as of September 7, 1973) with standards of performance and pretreatment standards. A general survey of exemplary feedlot operations is given with emphasis on the following: (1) A brief description to identify the salient features of the exemplary control concepts for a variety of livestock and poultry operations (with slides of actual facilities). (2) An illustration of applicability of the exemplary concepts to existing facilities with pollution problems, including geographic and climatic variability. (3) A review of the courses of action available to feedlot operations and responsible governmental and institutional officials. (4) An assessment of the general costs of achieving the effluent limitations for farms using current data estimates. The exemplary operations to be discussed include facilities involving open lot production of beef cattle, swine, and sheep; and, housed lot production for poultry, dairy cattle, swine, and beef cattle. Tables of associated costs for various sizes and types of facilities are presented. (Denit-EPA; Merryman, ed.)

**2601 - A5, A6, B1, F2 200**

### LEGAL ASPECTS OF ODOR POLLUTION CONTROL,

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P. M. Giblin
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 64-65.

Descriptors: Air pollution, Legislation, Feedlots, Livestock.
Identifiers: Odor abatement, Public hearings, Litigation.

Most legally recognized definitions of air pollution are written in nuisance terms. That is, they include some reference to "adverse effects on human health or welfare" or "interference with the normal use and enjoyment of animal life, vegetation or property." The Texas Air Control Board has been active in various enforcement actions involving odors from livestock feedlots. One successful lawsuit resulted in court-ordered relocation of the feedlot. Other suits have produced court-ordered nuisance abatement procedures. The proposed paper deals with the issues involved in determining a feedlot's compliance with air quality requirements. Also discussed are mechanisms for legal resolution of problems associated with feedlots. Public hearings are often held by air quality control agencies to review nuisance problems and examine possible corrective measures. If litigation is not warranted, an administrative enforcement order may be issued. In the drafting of such an order, technical and legal personnel work together to outline odor abatement steps and timetables for compliance. (Giblin-Texas Air Control Board)

### 2602 - A1, B1, E2 200
### PARTNERSHIP IN POLLUTION CONTROL,

Illinois Pollution Control Board, Chicago, Illinois
R. T. Odell
Managing Livestock Wastes, Proceedings 3rd International Symposium on lifestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 66-67.

Descriptors: Water pollution, Legislation, Feedlots, Illinois.
Identifiers: Pollution control, Waste management, Permits.

The 1970 Illinois Environmental Protection Act established the following 3 organizations for environmental protection: (1) The Pollution Control Board, which establishes regulations to protect the environment and sits as a quasi-judicial body that rules on cases of alleged violation of regulations; (2) The Illinois Environmental Protection Agency which monitors the environment and which, along with citizens, brings alleged polluters before the Pollution Control Board; and (3) The Illinois Institute for Environmental Quality, which collates environmental information. The current Illinois Livestock Waste Regulations are intended to meet requirements of the National Pollution Discharge Elimination System, established by the Federal Water Pollution Control Act Amendments of 1972. The most important provisions provide for the handling, storage, and field application of livestock wastes; for existing and new livestock facilities to be constructed to prevent excessive outside surface waters from flowing through the feedlot and to direct feedlot runoff to an appropriate disposal or storage area, and the location of new livestock facilities with regard to surface waters, flood plains, unsatisfactory soil conditions, and population centers. Procedures were established for inspecting feedlots under investigation. Permits are required of livestock operations with a total of more than 1000 animal units, and other livestock operations with 999 to 100 animal units that are causing significant pollution to obtain a permit. (Odell-Illinois Pollution Control Board, Merryman, ed.)

### 2603 - A1, B1, F2 200
### THE NPDES DISCHARGE PERMIT PROGRAM FOR AGRICULTURAL POINT SOURCES,

Department of Agricultural Engineering, Purdue University, West Lafayette, Indiana
J. C. Nye
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 68-70.

Descriptors: Regulation, Feedlots, Permits, Effluent, Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin.
Identifiers: Federal Water Pollution Control Act, Point sources.

Congress passed the Federal Water Pollution Control Act Amendments on October 18, 1972. This Act has had far reaching impact on the agricultural community. Section 306(b) (1) (A) specifically identified "feedlots" as one of the point sources for which a "Federal Standard of Performance for New Sources" has had to be prepared. Concentrated animal feeding operations were identified as "point sources" of pollution in the Act, and therefore were required to apply for a National Pollutant Discharge Elimination System (NPDES) permit. This paper presents an explanation of how the agricultural portion of the NPDES program was implemented in Region V of the U.S. Environmental Protection Agency, for the states of Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. The methods employed to obtain applications from the large feedlots are described. The interpretation of the "Feedlot Point Source Category, Effluent Guidelines and Standards" as published in the February 14, 1974, Federal Register and the subsequent development of an agricultural permit form is discussed. The paper also discusses the interfacing of the Federal program with existing and proposed State programs for controlling pollution from feedlots. A brief review of the total NPDES program is presented. (Nye-Purdue University)

### 2604 - A1, B1, D1, E1 200
### TECHNIQUES THAT ARE SOLVING POLLUTION PROBLEMS FOR POULTRYMEN

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 71-73.

Descriptors: Poultry, Waste treatment, Waste disposal, Odor, Water pollution, Aeration, Dehydration, Economics.
Identifiers: Soil injection, Oxidation ditch, Refeeding.

Poultrymen, who have struggled in the past with the pollution problem, are now accepting research information and putting it into practice. Some techniques are not economically feasible at the present time but many are. Some of the more applicable and successful are: (1) The "High Rise" poultry house, when constructed and managed properly, has aided in preventing pollution and provides maximum flexibility. Site selection and preparation as well as proper drainage and management are key factors for success. (2) Soil injection has proven very successful where odors from spreading anaerobic material is the primary problem. This does not prevent "house odors" or odor from storage. Closed storages are required because soil injection may have to be a seasonal operation in many instances. (3) Dehydration can prevent odors if fresh material is used with proper equipment and adequate afterburners. Adequate markets are necessary if this is to be economically feasible. If the dehydrated product is approved for use as an animal protein supplement this will aid large producers with little land, tremendously. (4) The oxidation ditch, which has a higher investment cost, can aid producers located in populated areas. This can be operated practically odor free and the effluent and-or sludge can be spread almost anyplace, at any time, without offending anyone. Effluent cannot be admitted to waterways without further treatment. (5) Surface aeration, much like the oxidation ditch, reduces odors. Being outside it does not function as efficiently during cold weather, in northern climates. There may be some odors during the spring when microbial activity increases. It is subject to "slug loading" which may produce some odor and foaming. Sufficient volume and aeration are essential and it is probably more applicable in warm climate areas. (Ostrander-Cornell Univ.)

### 2605 - A5, B1 200
### MODIFICATIONS OF THE MICHIGAN STATE POULTRY IN-HOUSE DRYING SYSTEM,

Poultry Science Department, Michigan State University
C. C. Sheppard, C. J. Flegal, H. C. Zindel, T. S. Chang, J. B. Gerrish, M. L. Esmay, and F. Walton.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 74-77.

Descriptors: Design, Michigan, Dehydration, Poultry, Measurement.
Identifiers: In-house-drying system.

Recent reports at the Cornell Waste Conference (1974) and XIV World's Poultry Congress (1974) have given progress reports of the Michigan State In-House-Drying System. Recent modifications have been made: (1) to improve the in-house drying capability, (2) to decrease or even eliminate the pollution emissions from the house, (3) to eliminate the need for the afterburner on the manure dehydrator. Recent modifications include change from a V type trough waterer (that dripped or overflowed regularly) to a four inch continuous (formed in place) aluminum eave trough. A second change has been the modification of a stirring device to stir the manure being in-house-dried. A third recent change has been the addition of a recirculating in-house air system. The fourth change has been the addition of hydro-filter chamber (tower) to lessen or eliminate the emissions coming from the 5,000 bird house and the manure dryer. Measurements are being made on: (1) Moisture content of in-house dried manure with the new stirring device. (2) Moisture content of in-house dried manure with the addition of the recirculating air. (3) The emissions from the house before and after the hydro-filter. (Sheppard, et. al.-Michigan State University)

### 2606 - B1, D2, E3 200
### DESIGN OF A POULTRY MANURE DRYING SYSTEM FOR A 155,000 LAYERS EGG FACTORY,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 78-82.

Descriptors: Design, Poultry, Drying, Cattle, Cost analysis.
Identifiers: Czechoslovakia, Refeeding.

This paper presents technical information and operating experience on a poultry manure drying system based on an industrial flash dryer-pulverizer (ATRITOR, produced by Herbert Assn., Coventry, England) for the confined housing with the capacity of 155,000 layers at one of the most advanced Czechoslovak poultry farm. The farm yearly output makes 31 mills of eggs, 240 metric tons of meat, and 1300 metric tons of high quality dehydrated poultry manure used for feeding cattle. The manure processing system contains automatic manure scraping and its instant conveying into a trailer with each house of capacity of 10,500 layers. The fresh manure is transported to the drying plant, moisture is removed, and the dried material is conveyed to a cyclone and bagged with a capacity of 300-400 kgs per hour depending on the fresh manure moisture content. The system components and system parameters are described. The reason for the selection of the type of dryer and description of ATRITOR dryer-pulverizer. Scrubbing of the flue gas. Cost analysis and evaluation are made of the plant performance along with discussion of existing problems. (Koskuba-Czechoslovakia)

### 2607 - A5, A8, B1, C3, D4 200
### IN-HOUSE MANURE DRYING–THE SLAT SYSTEM,

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H. A. Elson and A. W. M. King
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 83-84.

Descriptors: Design, Poultry, Drying, Odor, Ventilation.
Identifiers: United Kingdom, Slat system, Fully-stepped cages, Flat-deck cages.

In-house manure drying systems are of benefit in deep-pit poultry buildings for several reasons: (a) They reduce manure moisture content, thus reducing its weight, rendering it easier to handle, and enhancing its value. (b) Problems associated with wet pits (ammonia, odors, flies) are avoided. (c) A more amenable environment is provided for staff and stock. (d) Odor emission from buildings is reduced. The slat system, developed in the United Kingdom, is an efficient and economical method of achieving these objectives—drying manure to 10-15 per cent moisture. The system has been used in deep-pit houses having downward flow ventilation systems, with fully-stepped or flat-deck cages. It may also be possible to develop a similar system for semi-stepped cage configurations. The technique is to collect manure falling from laying stock directly on slats which retain it in columns subjected to continuous drying. The system operates efficiently because (1) Fresh manure adheres continuously, producing tall columns with high surface area. (2) The warm ventilation air passes over these columns before being exhausted below the slats. (3) Heat is provided by stock as they metabolise the energy of the food, and air movement by the existing ventilation. It was found that slats 4-6 inches wide gave best results; that rapid initial drying results in excellent nitrogen retention; and that, at a low ventilation rate (0.5 c.f.m. per bird) atmospheric ammonia was 13 p.p.m. in a slatted bay and 26 p.p.m. without slats. (Elson and King-Agricultural Development and Advisory Service. Merryman, ed.)

## 2608 - A2, B1, F2 200

## CONTROL, COLLECTION, AND DISPOSAL OF FEEDLOT RUNOFF,

USDA, University of Nebraska, Lincoln, Nebraska
N. P. Swanson, L. N. Mielke, and C. L. Linderman
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 85-87

Descriptors: Regulation, Engineering, Design, Feedlots, Water pollution, Nebraska
Identifiers: Runoff control.

As a result of pollution control regulations, many feedlots have instigated pollution control measures; but often they have done so utilizing fallacious concepts and without sufficient knowledge and background of engineering principles. The application of proven soil and water engineering principles has provided adaptation of practices and facilities to abate the water pollution hazard. Collection of hydrologic data from feedlots and interpretation of meteorological records has provided values for the parameters and variables involved in designs. Applications include diversions to eliminate surface runoff into feedlots, terraces to control overland flow within feedlots, basins and solids traps for the collection of runoff transported solids, riser inlets and underground conduit for conveyance of collected runoff, sumps and pumps to provide lift for feedlot drainage where gravity flow is not possible, holding ponds for storage of runoff effluent, pumping and distribution equipment for applying the effluent to the land, and management of effluent on crops, and soils for nutrient utilization and control of pollution hazards. Full consideration of applicable practices and techniques and avoidance of stereotyped concepts is necessary in engineering for pollution abatement of outdoor feedlots. Even then, failures can occur. The design of runoff controls on a feedlot must also provide for animal comfort, minimize management requirements, and keep investment and maintenance costs commensurate to potential income and benefits to the environment. (Swanson-USDA: Merryman, ed.)

## 2609 - A2, B2, E2 200

## MANAGEMENT OF RUNOFF WATER IN RELATION TO FEEDLOT OPERATIONS,

Hydraulic Engineer, USDA-Soil Conservation Service, Temple, Texas 76501
H. N. McGill and G. C. Vittetoe
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 88-92

Descriptors: Agricultural runoff, Feedlots, Economics, Lagoons, Irrigation.
Identifiers: Land disposal.

Presently, the most practical and economical system for cattle feedlot runoff control is one where (1) as much outside drainage as possible is diverted from the feedlot, and (2) the runoff water from the feedlot proper is intercepted and impounded in holding ponds, and later disposed of on agricultural crops. Disposal lagoons designed to treat solid and liquid wastes from feedlots have very limited application in cattle feedlot pollution abatement systems due to the size of the surface areas required for such lagoons. Therefore, systems of retention and irrigation which result in a "no-effluent" condition are the type best suited for cattle feedlots. In planning and designing the retention-and-irrigation-type abatement systems, the size of irrigated area in relation to the area of the feedlot must be considered for the varied conditions that can be encountered. This paper illustrates the development of cattle feedlot runoff management tools that can be used for a wide range of climatic and management conditions. These tools relate annual precipitation to feedlot storage requirements and irrigation area-feedlot area ratios needed to prevent spills for specific frequencies. These can be used to (1) determine the size of area to prepare for disposal of runoff from a specific feedlot, (2) plan for the use of feedlot runoff as a source of irrigation water, (3) predict the climatic or moisture conditions at times when holding ponds must be dewatered and (4) evaluate the influence which storage capacity of holding ponds has on frequency of spillage from the ponds and the timing of irrigations with the runoff water. (McGill and Vittetoe-USDA. Merryman, ed.)

## 2610 - A2, B2, D1, E2 200

## AN ILLINOIS FEEDLOT RUNOFF CONTROL PROJECT,

Dairy Farm Owner, Jo Daviess County, Illinois
R. Lawfer
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 93-95

Descriptors: Illinois, Feedlots, Design, Sprinkler irrigation.
Identifiers: Runoff control, Settling basin, Land spreading.

A report is given on the experiences and observations of a farm owner-operator concerning the operation of a livestock waste management system installed on his farm in northwestern Illinois in the summer of 1973. This project was designed to prevent possible point source pollution from this feedlot, and to provide needed research on water quality, engineering design standards, and on disposition of livestock wastes. A continuing study by the University of Illinois involves collection and analysis of samples of water, plants and soil, to monitor the levels of chemical substances from manure in nearby wells and streams, and in soil. An up-to-date summary of results from this study is in this paper. This "zero runoff" system includes a diversion, earthen dikes, a concrete basin for settling out waste solids, and a holding pond for temporary storage of liquids. Solids from the feedlot and settling basin are moved with solid manure handling equipment and spread on pasture or cropland. All contaminated runoff and liquid wastes from the feedlot are stored until they can be applied to the soil. A small solid set and movable irrigation system is used to empty the holding pond. Liquid from the pond can be applied through sprinklers to seven (7) acres of cropland. Alternatively, a drain pipe allows pond liquid to be applied by gravity to a small area of permanent pasture by use of perforated pipe. The paper includes the author's evaluation of the system's performance during eighteen (18) months of operation. Management skills and minor changes in design standards are recommended in his conclusions. (Lawfer-Illinois; Merryman, ed.)

## 2611 - A1, B2, E2 200

## FEEDLOT WASTE RECYCLING WITH A FLUSH CLEANING SYSTEM,

Department of Agricultural Engineering, Clemson University, Clemson, South Carolina
C. L. Barth and R. W. Goethe
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 96-97.

Descriptors: Feedlots, Waste storage, Waste disposal, South Carolina, Design, Lagoons, Sprinkler irrigation, Southeast. U. S.
Identifiers: Flush waste handling system, Land disposal.

Feedlots in the Southeast United States, due to high rainfall, require large amounts of labor and equipment to handle animal waste in solid form. Adverse weather conditions and cropping systems prevent continuous operation of solid waste handling equipment on cropland and interrupt work schedules. To combat the waste handling problem, odors and to reclaim plant nutrients by recycling, Walworth Plantation near Eutawville, South Carolina, constructed in 1973 a 5,000-head capacity feedlot with a (water) flush waste handling system. This type system is not new to the animal industry but is unique in the beef feedlot industry. The feeding layout is constructed in a "V" shape with 20 pens on each slope. The pens have a uniform slope of 2 and one half per cent to a central collection canal. Each pen is 30 feet wide, 120 feet long with a capacity of 125 head of cattle. The pens are constructed back to back with an unpaved working alley between the rows of pens. The central collection ditch diverts all runoff waste and water into a large concrete holding tank equipped with an agitator. The waste is agitated and pumped with a manure pump to a sprinkler irrigation system. The waste is applied on forage crops and pastures. As a back-up system in case of mechanical failure or prolonged adverse weather conditions, a 2 and one half acre excavated lagoon and a 15-acre natural lagoon can be used to prevent discharge to streams and to comply with effluent guidelines for the feedlot industry. Walworth Plantation has approximately 1,900 acres in cultivated crops and pasture that can be used for waste application. Presently, the waste is being utilized on 300 acres and 600 acres and can be covered with equipment on hand. (Barth-Clemson University)

## 2612 - B2, E3 200

## OPERATION OF BEEF MANURE FLUSHING SYSTEM IN A COLD CLIMATE,

Beef producer in Ada, Minnesota; Assistant Professor of Agricultural Engineering, University of Minnesota, St. Paul, Minnesota.
H. A. Natwick and P. R. Goodrich
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 98-100.

Descriptors: Confinement pens, Minnesota, Design, Lagoons, Waste treatment, Aeration, Recycling.
Identifiers: Flushing gutter, Waste water reuse.

An open beef housing unit for 100 animals was constructed to use a flushing gutter waste management system. Operation through two winters in Northern Minnesota show that the system will work satisfactorily in cold climate conditions. The owner had previously observed from his conventional solid floor cold confinement units that the manure remained pliable on the floors in below zero weather. Extreme conditions of -35 degrees F caused the manure to solidify, then again, became pliable when the temperature moderated to zero or above. The new complete system consists of a south facing open cold confinement building, three flushing gutters, a lagoon and necessary pumps and piping. The open front pole frame building is 50 feet wide with 36 feet of pen area and 416 feet long. Flushing more frequently during the winter months minimizes the possibility of freezing in the 12 inch flumes beneath the 2 inch slats in the floor. The 250 feet by 500 feet lagoon with an aerator treats the waste for recycling into the flushing system. Some difficulties were overcome in starting the system in early winter when bacterial population in the lagoon were minimal and the weather cold. Animal density has been the key factor in keeping the manure moving on the floor to the flushing slat. Low cattle densities allow manure to build up and subsequently freeze to a depth of a foot over the slat whereas, higher cattle densities keep the floor clear. This case study shows that flushing systems are feasible, even in cold temperature regions of Minnesota when managed properly. (Natwick and Goodrich-Minnesota)

### 2613 - A1, B2, E2 200

### UTILIZATION OF BEEF CATTLE WASTE FROM A SLOTTED-FLOOR DEEP-PIT BARN,

Manager, Larson and Taylor Feedlot, Maple Park, Illinois; Department of Agricultural Engineering, Illinois University at Urbana-Champaign
R. Larson, D. G. Jedele
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 101-103

Descriptors: Confinement pens, Illinois, Waste storage, Fertilizers
Identifiers: Slotted floor deep pit barn, Tanks, Land disposal, Application rates.

Three thousand head of cattle are marketed and 1500 acres of crops are grown annually by 2 and one half full-time workers on the Larson and Taylor farm near Maple Park, Illinois. Manure from the cattle is collected in 8-ft. deep tanks beneath slotted floors. The tanks are partially emptied in late August after pea harvest, completely emptied after corn silage harvest and completely emptied again in the Spring. Pumping, hauling, and spreading this manure requires about forty man days, but is usually accomplished in twenty actual days. This leaves 345 days per year when the waste management system needs little or no attention. Two men using two 3200 gallon tank wagons and one pump can empty two of the seventeen 80,000 gallon manure tanks in a day with an average two-mile round trip to the crop land. The maximum length of haul is three miles round trip. Applications to the soil have been at the rates of 3,000, 6,000 and 10,000 gallons per acre. Soil testing has been done to determine the value of the manure as a replacement for commercial fertilizer. The 1974 crops are to be weighed at harvest time to compare the effectiveness of the nutrients in manure with the nutrients in commercial fertilizer. Experience from prior years and calculations based on current commercial fertilizer prices indicate that the manure may return as much as ten dollars per head of cattle marketed. This return could quickly pay for the higher construction cost of a deep-pit barn compared to other beef confinement barns that have waste management systems that do not utilize the nutrients in the manure. (Larson and Jedele-Illinois)

### 2614 - B1 200

### EVALUATION OF DAIRY, BEEF AND SWINE WASTE HANDLING SYSTEMS,

Extension Agricultural Engineer, Michigan State University
R. L. Maddex, T. L. Loudon, L. R. Prewitt, and C. H. Shubert
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 104-106

Descriptors: Livestock, Dairy industry, Confinement pens, Waste storage, Design, Agricultural runoff, Nutrients, Labor, Maintenance.
Identifiers: Waste handling, Waste accumulation rates

A variety of systems for handling and storage of animal waste have been constructed in the last few years. Some of these have been designed by Soil Conservation Service personnel or Extension Agricultural Engineers, but others have been planned and built by farmers themselves often patterned after systems they have observed on other farms. A study to evaluate the design criteria, labor requirements, mechanical maintenance, and level of management associated with these systems has been initiated. Seven dairy farms were initially selected for waste management studies. Two of the farms are total confinement operations with the remaining five having a combination of free-stall and outside paved lots. All but one farm have manure storage facilities. Runoff collection ponds are in operation on each of the farms that have outside lots. The present project is being expanded to include additional dairy farms with different waste handling techniques as well as beef and swine facilities. The paper describes the waste handling techniques on each of the farms under study. Information will be reported on measurements of the rate of waste accumulation in storage facilities, nutrient content of the stored manure, and the relationship between precipitation and runoff from the various lots. The labor requirements and management techniques associated with the waste handling operations will be discussed. (Maddex, et al-Michigan State University)

### 2615 - B2, F1 200

### LARGE PISTON MANURE PUMPS AND OUTSIDE MANURE STORAGES (EARTHEN BASINS),

Department of Agricultural Engineering, Wisconsin University, Madison
R. E. Graves
Managing Livestock Wastes. Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 107-111

Descriptors: Dairy industry, Pumped storage, Lagoons, Wisconsin, Equipment, Costs, Design
Identifiers: Midwest U.S., Solid piston pump, Hollow piston pump

Because storage tanks under dairy barns of barnyards have such problems as high construction costs, gases and odors, and ventilation problems, some midwest dairymen are turning to storage ponds and lagoons. In the past conveying manure to these structures by means of tractor scrapers of conventional manure handling equipment has had its inherent problems. In 1972, large piston manure pumps became commercially available in Wisconsin. These pumps provide an automatic method for manure removal from a barn to an outside storage structure. Manure may be conveyed through up to 200' of 10'' or 12'' pipe to the bottom of a storage area. The two variations in pumps are a "solid piston pump" which handles manure with or without long fibrous material, and a "hollow piston pump" which handles manure without long fibrous material. The hollow piston pump is cheaper and more readily available and is presently the most popular with free stall barns. This paper reports on experiences with these systems, particularly agitation and emptying of these rather large (100' to 200') earthen storage units. Various designs, pumping units and management methods are used. (Graves-Wisconsin University; Merryman, ed.)

### 2616 - A1, B1, E2, E3 200

### MILKING CENTER WASTE MANAGEMENT,

Department of Agricultural Engineering, Pennsylvania State University, University Park
H. D. Bartlett, A. E. Branding, L. F. Marriott, and M. D. Shaw
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 112-113

Descriptors: Dairy industry, Recycling, Irrigation, Effluent, Nitrates, Nutrients, Odor
Identifiers: Waste management, Land disposal, Manure separation bed, Flushing, Groundwater quality

A system was developed to manage the total waste from a 150 cow milking center (holding area, milking parlor and milk house). Pipeline cleaning water is recycled for parlor cleaning and parlor cleaning water is recycled for flushing the holding area. The manure is removed by an automatically controlled separation chamber which has been developed and the effluent is distributed by an automatically controlled irrigation system to agronomic land. The soil and crops were analyzed for nitrate-N build-up and nitrogen level, respectively, to determine maximum effluent application rates consistent with maintaining groundwater quality and safe nitrogen levels of forage grown on the effluent disposal area. A major innovative feature of the system is the manure separation bed that utilizes a combination of settling and screening principles which removes the fibrous components of the manure to render an effluent that will allow completely clog-free pump operation for automatic control. Manure is removed from the separation bed with a front-end-loader at three month intervals. The respective components (manure and effluent) were analyzed for crop nutrient value and odor quality. (Bartlett, et al-Pennsylvania State University)

### 2617 - B1, D1, E1 200

### WASTE MANAGEMENT AT HALL BROTHERS DAIRY,

Extension Agricultural Engineer, Auburn University, Auburn, Alabama
H. Watson, H. E. Hamilton, D. Hall and T. McCabe
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 114-116

Descriptors: Dairy industry, Confinement pens, Separation techniques, Recycling, Lagoons, Aerobic condition, Anaerobic conditions, Irrigation
Identifiers: Flushing, Screening, Solids removal

Hall Brothers Dairy, located near Snowdoun, Alabama, is a 1200-cow total confinement system. Automated flush type manure handling is an integral part of the operation. Manure is removed from the milking parlor, holding lot area, and feed and housing areas by flushing with high volumes of water during each milking period. The estimated water requirement for the system is approximately 125,000 gallons per day. Manure laden flush-water from the system is collected in two 8000-gal. underground collection tanks. A 10-horsepower agitator stirs the material while it is being pumped over a gravity flow type screen. Solids removed by the screen are collected in a concrete pit located below the machine. Preliminary analysis of the solids removed by the screen indicate that the solids have a moisture content of approximately 60 per cent and contain approximately 3 per cent protein. These separated solids have many potential uses. Recycling as feed for cattle, bedding for the free stalls, and field spreading have all been tried on an experimental basis at Hall Brothers Dairy. Additional tests and analyses are being conducted to determine the value of this material as a feed ingredient, as bedding and as fertilizer. Water leaving the screen is processed through a 3-cell lagoon system where both anaerobic and aerobic processes further reduce its pollution potential. Overflow from the lagoon system is controlled through the use of an irrigation system installed between the second and third cells. Effluent in the lagoons is used for irrigation during periods of low rainfall, allowing the lagoons to collect runoff and flush water during the winter months. Further study is under way. (Watson, et. al.-Alabama; Merryman, ed.)

**2618 - B2 200**

## ADAPTATION OF A BRITISH WASTE MANAGEMENT SYSTEM TO THE U.S. ENVIRONMENT,

Howard Harvestore, Ltd. Saxham, Bury St. Edmunds, Suffolk, England
P. Jensen, G. Newman, and A. J. Peters
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 117-120.

Descriptors: Waste storage, Slurries, Design, Testing
Identifiers: Waste management, United Kingdom, Harvestore

In the United Kingdom extensive and increasing use is being made of livestock waste management systems which feature above ground storage of liquid manure during seasons of the year when spreading on fields is either impossible because of bad weather or impractical because of poor timing for fertilizer application. Two factors have stimulated this activity—anti pollution legislation and the rapidly increasing cost of chemical fertilizers. Howard Harvestore, Ltd., joint venture partner of A. O. Smith Harvestore Products, Inc., has been notably successful in the application of open top, above ground liquid manure storage vessels, called slurrystores, made of glass-coated steel Harvestore sheets. Their success in the U.K. environment has prompted much interest on the part of U.S. Harvestore dealers who want to apply the same kind of equipment to livestock pollution control in the U.S. Therefore a product design and development project, reported here, was set up with the purpose of testing the suitability of the slurrystore system in the U.S. environment, where seasonal temperatures both far above and far below the norm in England might make direct adaptation of the English system difficult. During the winter and spring of 1974, operational testing was conducted with four prototype systems, including two in Wisconsin, one in Missouri and one in Texas, with a variety of types and makes of pumps for loading, recirculating (agitating) and unloading the Slurrystore structures. Some unexpected problems did arise but have been successfully resolved and the general conclusion of this work is that the above ground Slurrystore system, properly equipped and managed, can solve the farmer's waste management problem, prevent pollution of streams, and provide a significant new application of Harvestore equipment to America's animal agriculture. (Jensen, et. al.-England and Illinois; Merryman, ed.)

**2619 - B2, E2 200**

## A LIQUID MANURE MANAGEMENT SYSTEM IN A TIE STALL DAIRY BARN,

Dairyman, Rolling Hills Farm, Watkins, Minnesota; Department of Agricultural Engineering, Minnesota University, St. Paul, respectively
G. S. Meierhofer, and P. R. Goodrich
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 121-122.

Descriptors: Liquid wastes, Dairy industry, Design, Waste storage.
Identifiers: Land disposal, Tie stall dairy barn.

Joining a tie stall dairy barn to a liquid manure system was the objective of the Meierhofer dairy facility. Efficient and timely collection, storage and utilization of the dairy manure, milking house waste, and exercise lot runoff was needed. For a total pollution control system two separate pits were used. A 30 foot by 32 foot pit beneath a pole barn is covered with a slotted floor. Manure from the young stock housed in the pole barn and runoff mixed with manure from the exercise lot are scraped into this pit. During suitable field spreading conditions, this tank is agitated, pumped and spread using a liquid manure tank. The bulk of the waste is handled in the pit beneath a two year old tie stall barn. Four compartments allow for agitation by sections when pumping out. The pit is offset 6 feet, so that there is no pit under 6 feet of feed alley in front of the cows on one side, but the pit extends 6 feet beyond the building on the other side. This offset allows easy access for agitating and pumping. Ventilation fans are permanently located on the offset and may be used during agitation to reduce the hazard of noxious gasses in the building. Most pumping ports require the fans to be removed to put the pump in. Gutters behind the cows in the tie stalls are equipped with grates so the manure will drop into the pit, yet protect the animal. The system has been in operation two years with excellent results. The four day pit cleaning process can be done when the land is not frozen. For a dairyman who prefers tie stalls to slotted floor and free stalls, this system has worked well. (Meierhofer and Goodrich-Minnesota; Merryman, ed.)

**2620 -B2 200**

## A COMPLETE DAIRY LIQUID MANURE SYSTEM,

Biological and Agricultural Engineering Department, Rutgers University, New Brunswick, New Jersey 08903
W. J. Roberts, M. E. Singley, and D. R. Mears
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 123-125.

Descriptors: Dairy industry, Liquid wastes, Waste storage, Ventilation, Odor.
Identifiers: Land disposal.

A complete liquid manure handling system was one objective of a 40-cow innovative dairy research facility. Liquid manure handling, free choice stalls and self feeding of silage create a relatively labor-free system with minimum energy and machinery requirements. All equipment operations occur outside the area of freedom given to the animals. The liquid manure collection and storage system includes a circular slotted manure trench 4 feet deep, a pump and a large external holding tank with the pumping port and ventilation equipment located on the tank top. The manure system forms part of the ventilation system which controls moisture, temperature and odors and gases produced in the trench. The trench is located between the circular feeding platform and the outer ring of free stalls. The trench is flushed by recirculating material from the holding tank. Manure pumped into a closed transport is incorporated directly into the soil in one operation by using the plow-furrow-cover technique. The performance of the ventilation system in conjunction with the manure system is outstanding. Malodors are only present at the ventilation outlet during the flushing operation pumpout. Methods have been evaluated for treating the exhaust air at these times with oxidizing agents. Corrosion of the ventilation equipment, louvers, and fans, is a severe problem. The liquid manure system has worked well for an extended period of time. (Roberts, et. al.-Rutgers Univ.; Merryman, ed.)

**2621 - A5, B2, D4, E2 200**

## A WASTE MANAGEMENT SYSTEM FOR A 150-COW DAIRY—A 10-YEAR CASE STUDY,

Department of Agricultural Engineering, Purdue University, West Layfayette, Indiana
A. C. Dale, J. L. Albright, J. C. Nye, and A. L. Sutton
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975. University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 126-129.

Descriptors: Dairy industry, Lagoons, Irrigation, Clogging, Pumping.
Identifiers: Waste handling.

Some of the problems and successes of the waste handling facilities at the 150-cow Purdue Dairy Farm Center are described. Odor complaints and large labor load caused the farm to modify their solid waste handling facilities so that all wastes could be handled as a liquid. Two 34,000 gallon circular concrete holding pits were constructed. The manure was scraped to these holding pits, diluted with water, mixed and pumped with an impeller manure pump and hauled to nearby fields for disposal. However, odor was still a problem. Further measures were taken through the years. A small sedimentation lagoon was constructed to control excess runoff. An aerator was placed in it to control odors. Later, a large anaerobic lagoon was constructed which received all the wastes. It was dewatered annually by conventional irrigation equipment. However rapid increase in solids level caused clogging problems in the nozzles. In 1973, a large 40 hp pump was employed to drive the irrigation system. It also developed clogging problems. The final solution for dewatering the lagoon was two pumps in series. The first pump was a large capacity trash pump; the second was the 40 hp unit already discussed. Experience with this system led to several conclusions. Material which will not decompose should not be added to lagoons to be used with irrigation systems. If mechanical and hydraulic devices are to be employed, some method of keeping the large nonbiodegradable particles out of the waste is necessary. A solid waste handling should still be used for handling the lot scrapings particularly if bedding is used with large particles in it. If these large solid materials are removed, the lagoon system with irrigation dewatering works well for handling the dairy lot runoff. (Dale, et. al.-Purdue University; Merryman, ed.)

**2622 - B2, D4, E3 200**

## SELF UNLOADING PITS IN A DAIRY MANURE MANAGEMENT SYSTEM,

Dairymen, Litchfield, Minnesota; Department of Agricultural Engineering, Minnesota University, St. Paul
W. R. E. Euerle, G. O. Euerle, and P. R. Goodrich
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 130-131.

Descriptors: Waste storage, Waste disposal, Dairy industry, Lagoons, Costs, Labor, Sprinkler irrigation.
Identifiers: Land disposal.

Short term storage of daily manure beneath slats coupled with pull gates on the pits for emptying into a lagoon minimize cost and labor in this system. A high capacity sprinkler system removes the waste from the lagoon at infrequent intervals for recycling onto land. Brothers, William and Gerald Euerle find that the system is easy to operate and effectively controls the waste from a 75 cow freestall operation. Utilizing an elevated location for the barn about 50 feet from a detention pond, they collect the manure and milking parlor waste in a pit beneath the barn. The pit has storage capacity for about 2 months. Cleaning is done by lifting a wooden gate at the end of the north portion of the 3 section pit. This forces the fairly liquid portion of the waste in the section beneath the feed bunk to flush first, the south section and then, the north section. The flowing material clears the solids well and moves to the lagoon down a channel in the hill slope. Anaerobic action in the lagoon has not forced ducks to leave and has not given off objectionable odors. Solids have not filled the lagoons to an extent to require cleaning. The self-powered moving big gun sprinkler and centrifugal pump move the liquids to final disposal on nearby fields very quickly. The total system recycles the manure with low labor cost and without excessive investment cost. Daily winter spreading and its environmental hazards have been eliminated. (Euerle, et. al.-Minnesota)

### 2623 - A1, A4, B1, D4, E2, F2 200
### A PLANNING STUDY ON DAIRY WASTES MANAGEMENT,

Vice President, Albert A. Webb Associates, 3788 McCray Street, Riverside, California 92506
S. I. Gershon, S. A. Hart, A. C. Chang, and J. W. Branch, Jr.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 132-135.

Descriptors: Dairy industry, California, Water pollution, Groundwater pollution, Salts, Regulation.
Identifiers: Land disposal, Compost, Evaluation.

The major milkshed for Los Angeles, California is in the Chino Basin of the Santa Ana River Watershed, 25 miles east of Los Angeles. Approximately 165,000 dairy cows are located within a 120 square mile area. The manure from these animals is either applied to nearby farm fields or exported as "compost." Nevertheless, mismanagement of waste storage and disposal contributes to surface and groundwater pollution problems. Concern about water pollution prompted the Santa Ana Watershed Planning Agency to retain consultants to study and recommend various management plans, including waste handling from various pollutant contributors. In one such study, the consultants hoped to determine economically feasible methods by which the dairy industry could reduce the amount of "salts added" (about 50,000 tons of salt—total dissolved solids—per year) to the groundwater basin from the dairy industry by 90 per cent. An extensive data-gathering program was initiated. The extent of the salt problem was determined. Alternative means of collection, treatment, and disposal of the waste streams were evaluated. An economic analysis of the feasible alternative methods was made along with recommending a plan. Study results are given in detail. (Gershon-Albert A. Webb Associates; Merryman, ed.)

### 2624 - A1, B1, C5, D2, E4, F1 200
### DAIRY WASTE FIBER—A BYPRODUCT WITH A FUTURE?,

Extension Agricultural Engineer, California University, Riverside
W. C. Fairbank, S. E. Bishop, and A. C. Chang
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 136-138.

Descriptors: Dairy industry, Separation techniques, Recycling, Litter, Soil amendments.
Identifiers: Dairy waste fiber, Hydromulching, Refeeding.

The dairy industry of California has for years enjoyed labor saving benefits of flush cleaning of manured concrete areas. In 1967 mechanical separators to screen coarse suspended particles and fiber from the liquid waste entered the scene. By 1972 large volumes of dairy waste fiber (DWF) were in neat storage piles throughout our dairy regions. Potential values in DWF were sought by two routes of investigation: (1) Consider the natural fibrous products in agricultural use, and compare by cursory evaluation the gross similarities and differences of DWF; (2) Examine DWF in sundried, sanitized, size fractionated form, and ascribe component values based on competitive materials. Related production techniques for handling, processing, packaging and merchandizing were concurrently developed in light of increasing energy costs and greater socio-environmental regard. Solar drying of wastewater saturated DWF in a thin bed and with daily tractor stirring was confirmed. Decomposition was arrested and an innocuous product resulted. Dry classification by mechanical screen into three particle sizes produced material of remarkable uniformity and appearance. The course grade appears suitable for any common agricultural use of wood shavings such as livestock litter. The middle size fraction appears of interest to the hydromulching industry as a low cost substitute for wood pulp fiber. The fine grade contains most of the residual and secondary digestible protein which suggests it be directed to feed ingredient use. All grades have been blended into commercial manure-based planter mixes and have been substituted for peat moss or wood shavings for general horticultural use. Environmental impact is nil, energy balance positive, economics and public acceptance favorable. (Fairbank, et. al.-Riverside, California; Merryman, ed.)

### 2625 - A1, B2, E2 200
### THE DAKOTA SYSTEM—A METHOD OF COLLECTING, STORING, AND HANDLING ANIMAL WASTE,

USDA, SCS, Box 878, Bismarck, North Dakota
D. F. Meyer
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 139-140.

Descriptors: Dairy industry, Liquid wastes, Slurries, Waste storage, Design, Pumped storage.
Identifiers: Dakota System, Land disposal.

The Dakota System is a slurry or liquid manure handling system. By definition, waste having more than 96 percent water is liquid manure, 80-95 per cent water is slurry (after proper agitation), and less than 80 per cent water is semi-solid. The Dakota System is primarily used in free stall dairies. The system includes a concrete tank with a capacity of seven days storage. A chopper pump requiring sixty horse-power or more connected to a ten or twelve inch P.V.C. pipeline conveys the waste to an earth holding pit which has a storage capacity of 180 days. Side slopes are one to one and end slopes are four to one. The Dakota System enables the dairy man to maintain sanitary conditions in all but the most severe weather. Odor is minimal because the seven day storage does not allow substantial biodegradation. A single chopper type pump enables the operator to empty the concrete pit, agitate the outside pit and load honey wagons for removal to the field. Surface of the earth holding pit generally freezes during winter. It remains frozen for a period of several days to a few weeks after spring break-up, helping keep the manure in good condition. Installation costs are kept low by utilizing a single pump. Waste water from the milking parlor is discharged directly into the concrete tank. This eliminates a waste problem and increases liquid content during periods of high evaporation to improve pumpability of the slurry. A recent pump trailer design eliminates pumping port, reducing costs and increasing flexibility for agitation. (Meyer, USDA; Merryman, ed.)

### 2626 - A1, B1, E2 200
### MANURE PONDS FOR MINIMIZING POLLUTION,

District Conservationist, Soil Conservation Service, Kewaunee, Wisconsin 54216
A. C. Marini, O. J. Berry, and M. L. Knabach
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 141-143.

Descriptors: Wisconsin, Dairy industry, Costs, Design, Waste storage, Equipment, Water pollution.
Identifiers: Waste handling, Land disposal.

Wisconsin has long been noted for the production of dairy products. Throughout the years, the size of the dairy farms has steadily increased. However, the proximity of many of the livestock yards to perennial streams, many of which are trout streams, has not changed. As a result, the larger herds have increased the problem of handling the large volumes of manure produced each day. One method of handling these livestock wastes which has become very popular in some sections of the state involves the use of manure pumps. Although the number of companies which fabricate manure pumps are few, a considerable number of these types of installations have been made. Many of these systems have been very successful. The manure has been removed from the buildings and successfully stored for the desired period of time while greatly reducing surface water pollution. This paper describes the design and operation of a complete manure handling system for a farm located in Kewaunee County. Although the total cost of this system was relatively inexpensive, the capacity is sufficiently large to store the total manure accumulation of 100 cattle for the entire winter season. The paper covers three major items: (1) the design of the overall waste management system, (2) the operation of the system including the application of the animal wastes onto the land in a manner which eliminates pollution, and (3) the equipment used and a description of the storage facilities which effectively use earth embankments to store the waste. (Marini, et. al.-Wisconsin; Merryman, ed.)

### 2627 - A1, B2, D2, D4, E3 200
### A TOTAL RECYCLE UNIT SYSTEM FOR DAIRY MANURE MANAGEMENT,

Department of Agricultural Engineering, Purdue University, West Lafayette, Indiana
A. C. Dale and R. Swanson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 144-146.

Descriptors: Recycling, Dairy industry, Waste treatment, Slurries, Fertilizers.
Identifiers: Pollution control, Bedding, Soil conditioner, Refeeding.

This paper describes the Total Recycle Unit (TRU) System, developed by Babson Bros. Co., Oak Brook, Illinois, to mechanically handle and treat dairy cow manure. With the TRU System, part of the manure is converted to readily reusable products and the remainder is converted into non-pollutional end products. A field trial unit is undergoing final observations and monitoring prior to tooling up for production in the near future. The complete TRU System processes raw dairy cow manure as follows: (1) homogenizes the manure into a slurry in a primary collection tank, (2) pumps the slurry through a solids-liquid separator, (3) washes the first separated solids with "clean" water to further remove mucous and dissolved solids, (4) ejects washed and final separated solids to a storage for use as bedding, as a soil conditioner, or for refeeding to beef cattle, (5) returns some liquids to the mixing tank to dilute the incoming manure, (6) pumps the remaining liquid to the following: (a.) a storage for holding until irrigated onto cropland, (b.) an aerator and thence to an electroflocculator for removal of minerals, (7) pumps the colored water through a clarifier producing a clear reusable or dischargeable water. In summary, the complete TRU System produces "clean" solids, concentrated fertilizer and clarified water from dairy cow manure. However, only part of the system may be selected. For example, the electroflocculator could be eliminated with the liquid going directly to the holding unit for eventual use as a fertilizer or a substrate for bacteria for synthesize into proteins. (Dale and Swanson-Purdue University)

### 2628 - A1, B2, E2 200
### SUCCESSFUL MANURE MANAGEMENT SYSTEM FOR A LARGE COMMERCIAL HOG OPERATION,

Gehlbach Pork Farm, Lincoln, Illinois; Extension Agricultural Engineer, University of Illinois, Urbana
G. D. Gehlbach and A. J. Muehling
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 147-149

Descriptors: Waste storage, Lagoons, Fertilizers, Phosphorus, Crop response.
Identifiers: Swine, Waste management, Land disposal, Slotted floors.

Gehlbach Pork Farm in Logan County, Illinois, markets approximately 8,500 hogs per year. As this hog operation has increased, a major concern has been to develop an acceptable waste handling system. All hogs except the breeding herd are raised in confinement under roof. Most buildings are fully slotted with storage pits underneath which provide 3-5 months storage. Manure is disposed of in two ways: (1) hauling from the pits with a vacuum tank wagon with soil-injection attachment and chiseled in the ground for fertilizer, and (2) lagooning. This results in almost odor-free disposal of the manure. The pits are emptied completely in the fall before freezing. As much manure as possible is hauled in the spring before the corn is planted, occasionally resulting in some late planting. A small amount of land is left idle through the summer for manure disposal. The scarcity and price of commercial fertilizer is encouraging better distribution, and application is being made on the most nutrient deficient soils. A 7 and one half acre lagoon is a backup and used for overflow only when the pits fill up. The lagoon is pumped down when necessary to keep it from overflowing. Comparisons of land receiving commercial fertilizers with land receiving manure indicate that in the latter extremely high values of phosphorus occur, but yields don't seem to be affected. This could be classified as one successful method of handling swine wastes on a large commercial farm. (Gehlbach and Muehling-Illinois; Merryman, ed.)

### 2629 - A1, B2, E2, E3 200

### EXPERIENCE WITH OPEN GUTTER FLUSH SYSTEMS FOR SWINE MANURE MANAGEMENT,

Department of Agricultural Engineering, Maryland University, College Park
H. L. Brodie
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 150-153.

Descriptors: Confinement pens, Maryland, Economics, Design, Lagoons, Recycling, Irrigation.
Identifiers: Swine, Waste management, Open gutter flush system.

Several swine producers in Maryland have constructed new confinement facilities for swine utilizing the open gutter flush system for manure collection and transport. Two different farms are examined to determine the overall economic, management, labor and production efficiencies of this waste management system. The experiences of construction, operation, and management are reviewed. On one farm a 250 foot long swine finishing building and a 120 foot long gestation building are flushed. The gutters are four feet wide by four inches deep with floor slopes of one and two per cent. Waste water enters a three-fourth acre lagoon from which water is recycled for flushing. All structures were constructed with farm labor. The second farm flushes a 250 foot long finishing house utilizing a four foot wide by four inch deep gutter. Waste water is collected in a liquid manure tank and spray irrigated on nearby grassland. Well water is used for flushing. The structure was completely constructed with contracted labor. Two different designs of automatic dumping hopper type flush tanks are in use. The development of water use practices is dependent on the disposal method. Strict conservation is observed for the spray irrigation system. However, the lagoon system uses a great volume of recycled water. Both systems work satisfactorily. The labor and management input into the waste handling system is significantly reduced without an excessive investment cost. (Brodie-Maryland University; Merryman, ed.)

### 2630 - A1, B1, D1, E2, F4 200

### SWINE PRODUCTION AND WASTE MANAGEMENT: STATE-OF-THE-ART,

Biological and Agricultural Engineering, North Carolina State University, Raleigh
M. R. Overcash, F. J. Humenik, and L. B. Driggers
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 154-159.

Descriptors: Swine, Economics.
Identifiers: State of the art, Waste management, Pork production.

An exhaustive review of over 100 pertinent articles has been compiled in association with an EPA grant to critically evaluate the composite production-waste management strategies in the United States. A comprehensive systematic survey of the pork production industry was also conducted to add dimension to assessment of actual producer operations and problems relative to waste management options. This combined literature review and survey as a state-of-the-art review can provide excellent direction for future regulations and pork industry growth patterns. Information from literature references, extensive data retrievals and calculations have put the available waste characterization data on a uniform and thus more useable basis. The raw waste load and waste stream from various composite production-pretreatment systems are included for such parameters as liquid volume, COD, TOC, TKN, $NH_3$-N, $PO_4$-P, solids, K and trace elements. Finally a regrouping of traditional production systems to reflect waste management considerations and economic costs for final application to plant-soil receiver systems is included. Such unit definition ranges from those with large volumes of wastewater or high nitrogen contents to those with minimal water and nitrogen in the waste stream. A discussion of the minimum cost effective parameters which could be monitored to evaluate or regulate performance of a waste management system with a terminal plant soil receiver system is included. (Overcash, et. al.-North Carolina State Univ.)

### 2631 - A5, B2, D4, E3 200

### SWINE WASTE NUTRIENT RECOVERY SYSTEM BASED ON THE USE OF THERMAL DISCHARGES,

Department of Agricultural Engineering, Oregon State University, Corvallis
J. R. Miner, L. Boersma, J. E. Oldfield and H. K. Phinney
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 160-163.

Descriptors: Recycling, Anaerobic digestion, Algae, Methane, Design.
Identifiers: Swine, Nutrient recovery system, Thermal discharges, Single cell protein, Waste water reuse.

The feasibility of using waste heat from steam electric plants to sustain a food producing complex in which nutrients are recycled is being analyzed. Microorganisms are being used to convert animal manures into a high protein livestock feed and a methane rich fuel gas. Waste heat from the steam electric plants is used as a low cost source of energy for maintaining stable, elevated temperatures in anaerobic digestion and single cell protein production units. Much of the technology of the individual units is currently available. The objective of this project was to develop a system utilizing these units together and to establish design and operating criteria. The system consists of anaerobic digestion for liquifaction of solid material and soluble nutrient recovery by growing algae in basins heated with waste heat. The components of the system include: hydraulic manure transport, a solid-liquid separator, an anaerobic digester, aerobic basins for growing algae, harvesting equipment, and a soil-bed filter system for final removal of nutrients. The nutrient requirements of algae cultures are similar to the waste characteristics from swine. The design of the facility is based on the waste production of fifty swine. The facility is a livestock confinement building where the manure is flushed from the animal pens and routed to the nutrient recovery system. Flushing is done with sufficient frequency to prevent anaerobic decomposition and associated odors within the building. Clarified liquid from the nutrient recovery system is re-used in the process to flush wastes from the building. (Miner, et. al.-Oregon St. Univ.; Merryman, ed.)

### 2632 - A1, B2, D4, E2 200

### MANAGING A SUCCESSFUL LIQUID SWINE MANURE MANAGEMENT SYSTEM,

President, Leanco Corporation, P.O. Box 879, Brownwood, Texas 76801
P. R. George, J. M. Sweeten, and S. J. Buchanan
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 164-167.

Descriptors: Liquid wastes, Waste treatment, Lagoons.
Identifiers: Swine, Storage pits, Land disposal.

A modern 600-sow farrow to finish operation in Central Texas employs a three-phase system of efficiently managing liquid swine manure. This system has proven itself through legal battles and serves as a model for the swine industry in Texas. The feeding system consists of two enclosed farrowing houses; two adjoining nurseries and eleven partially-covered finishing buildings. The two enclosed slatted-floor farrowing houses are underlain by ventilated 4' deep liquid manure storage pits. Separate storage pits are provided for each 30-sow room within the farrowing house to facilitate clean-out and enhance disease control. In all other buildings, liquid manure pits (beneath fully and partially-slatted floors) extend the length of the buildings. Anaerobic treatment is provided in these continuous flow storage pits, which have a theoretical manure storage capacity (detention time) of 70 days. Through experience, the operators have arrived at a program of withdrawing settled solids from the storage pits without agitation at two to three week intervals using honey wagons. This method of sludge handling was compared with chemical treatment of the pits from the standpoint of odor control; results will be reported. Sludge is hauled to adjacent fields and disposed of through plow-furrow-cover. Odors and flies are effectively controlled. No additional fertilizer is needed on the 100 acres of Coastal Bermudagrass pasture. Finally, liquid overflow from the manure storage pits is conveyed one half mile into a facultative-anaerobic lagoon for further treatment and eventual land disposal. This lagoon also receives runoff from the 100-acre solids disposal area and is designed to contain the 25 year frequency, 24 hour duration storm. Besides meeting the zero-discharge standard for both the feeding area and manure disposal area, the operation has been monitored for possible groundwater pollution problems. To date, piezometers have indicated no evidence of seepage from either the lagoons or from the liquid manure storage pits. (George, et. al.-Texas; Merryman, ed.)

### 2633 - A1, B2, D4, E2 200

### TOTAL WASTE MANAGEMENT FOR A LARGE SWINE PRODUCTION FACILITY,

Manager, Lexington Swine Breeder, North Carolina
F. J. Humenik, R. E. Sneed, M. R. Overcash, J. C. Barker, and G. D. Wetherill
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 168-171.

Descriptors: Costs. Sprinkler irrigation, Ammonia.
Identifiers: Swine, Waste management, Land disposal, Zero discharge, Volatilization, Aerated basin, Anaerobic lagoon.

Consistent with developing animal waste management technology, this total system is centered around nitrogen and the pretreatment processes prior to terminal land application for the most feasible approach to a zero discharge system. The maximum production capacity of this breeder facility is about 200,000 lb on-farm liveweight. Facilities have been developed to minimize wastewater generation in the totally enclosed buildings with manure storage pits under partially slatted floors. Site alterations included creek rerouting to optimize the production-waste management system. Wastewater pretreatment processes are a surface aerated basin (87,000 $ft^3$) followed by an unaerated anaerobic lagoon. In addition, liquid from the unaerated lagoon is applied to a 1.5 acre site in which overland flow pretreatment is accomplished with this wastewater returning to the unaerated lagoon. Piping in conjunction with the overland flow and terminal irrigation system also allows use of secondary lagoon water for pit precharge and positive cleaning after pit emptying. These pretreatment processes effect nitrogen losses by ammonia volatilization and nitrification-denitrification as well as some degree of odor control. Final treatment or disposal of lagoon effluent is accomplished by a permanent set sprinkler system with manual control of laterals. The operational strategy, installation costs, and on-going costs are included. (Humenik, et. al.-North Carolina)

### 2634 - A1, B2 200

### SIMPLIFYING MANURE HANDLING IN A SOLID-FLOOR SWINE HOUSING SYSTEM,

Farmer, R. R. 1, Monona, Iowa 52159
D. J. Meyer
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 172-173.

Descriptors: Design, Costs, Labor.
Identifiers: Swine, Waste management.

There are basically three types of liquid wastes systems being used in swine operations: (1) long-term pit storage, (2) inside treatment systems, and (3) systems that flush manure outside. Although these systems keep labor input low, there are drawbacks depending on the system chosen. The purpose of this paper is to present a building design which eliminates most of these drawbacks and yet has a low labor input. Specifically, the objectives were to: (1) minimize disease build-up, (2) minimize odor and flies, and (3) keep the costs low. The building design follows: The building is bounded by a generally-circular upright wall covered by a roof. Centrally located is a pit for receiving liquid and solid wastes. An annular imperforated floor extends outward from the pit toward the wall and is exposed for direct access to and walking upon, by the hogs. An elongated sweep means radially extends from a pivotal mount at the pit center for lateral movement around and over the floor in order to engage the solid wastes on the floor and propel them towards and into the pit. Surrounding the swept floor, but still within the enclosure, is a nesting region. For inducing the hogs to defecate only on the swept floor, (1) the nesting region is raised above the level of the swept floor, and (2) air circulation occurs so as to encourage the livestock to respect their nesting region. The building and waste system described were constructed and are currently in operation. (Meyer-Iowa; Merryman, ed.)

### 2635 - B2 200

### DOUBLE E. FARMS—SWINE INSTALLATION,

Owner and Operator of Double E Farms, 37 North Sylvan Avenue, Columbus, Ohio 43204
T. W. Eisenman and R. K. White
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 174-176.

Descriptors: Design, Lagoons, Costs, Equipment, Maintenance costs, Ohio.
Identifiers: Swine production.

The swine installation of the Double E Farm is located approximately 18 miles Southwest of Columbus, Ohio. The installation consists of the following: (1) Six outdoor breeding pens, each 145' x 35', (2) Gestation building, 292' x 23', (3) Farrowing and nursery building, 267' x 21', (4) Finishing building, 271' x 37', (5) Liquid waste lagoon, with a water area of 4.63 acre and a depth of 5'. Some of the major difficulties encountered since the system was put into operation are: (1) Unsatisfactory voltage conditions and high cost of electric energy due to physical location of installation with relation to electric energy supply source, (2) Aerator wheels were constructed of light gage material which resulted in a great deal of breakage. All wheels were rebuilt of heavy gage material, (3) Hog hair collected in wheel bearings causing many shut downs, (4) It was necessary to dilute liquid in building trenches by recirculating water from the lagoon, (5) Undigested oat husks built up a residue in the trench bottoms, (6) Sand from pre-mixed feed caused a build up in the trenches, (7) Over current relays were installed to protect the wheel motors from burn outs, (8) There were numerous belt breakages on the wheels. Under current relays were installed in the wheel motor circuits to sound an alarm when this condition occurred, (9) A buildup on the wheels of ammonium magnesium sulfate, (10) Aerob-A-Jet units were tested in lieu of aerator wheels but did not seem to do a satisfactory job, (11) Maintenance of equipment and inside of buildings is very costly. (Eisenman and White-Ohio; Merryman, ed.)

### 2636 - B2, D4, E2 200

### A WASTE MANAGEMENT SYSTEM FOR A 2500-HEAD SWINE OPERATION–A CASE STUDY,

Department of Animal Sciences, Purdue University, West Lafayette
A. L. Sutton, D. H. Bache, J. T. Nye, A. C. Dale, D. D. Jones, et. al.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 177-180.

Descriptors: Liquid wastes, Design, Costs, Lagoons, Anaerobic conditions, Irrigation.
Identifiers: Swine, Waste management, Oxidation ditch, Slatted floors, Land disposal.

This study (1) describes the design and (2) reports on the performance of a liquid waste management system for a 2500-head swine operation at the Baker-Purdue Animal Sciences Center, Purdue University, West Lafayette, Indiana. The farrow-to-finish operation includes two 800-head environmentally regulated confinement growing-finishing houses, two 48-crate environmentally regulated confinement farrowing houses, and two 120-head open-front confinement gestation houses. Four-foot deep race track-shaped oxidation ditches are located in the finishing and farrowing houses to collect, store and treat wastes. A four-foot anaerobic pit beneath a partially slatted floor collects and stores waste from sows in the gestation houses. Waste from all pits beneath the slatted floors is transported by gravity to a 2000-gallon sump tank system. The liquid waste is automatically pumped from the sump into an anaerobic lagoon with a submersible 3-hp electric vertical cantiliver high solids pump. Lagoon effluent is irrigated on adjacent land cropped to continuous corn. Investment and operating costs and labor requirements of the lagoon-irrigation system (tiling, sump, lagoon, irrigation) were compared to the liquid tanker wagon hauling system. Initial investment costs were higher for the lagoon-irrigation system. However, the lagoon-irrigation system required much less labor. Yearly operating and labor costs for the liquid hauling system were higher than the lagoon-irrigation system. It was concluded from this study that the lagoon-irrigation waste disposal system can be an attractive alternative for a large swine waste operation. (Sutton, et. al.-Purdue University; Merryman, ed.)

### 2637 - A5, B2, D4, E2 200

### KSU AEROBIC SWINE WASTE HANDLING SYSTEM (SIX YEARS OF PROBLEMS AND PROGRESS),

Department of Animal Science and Industry, Kansas State University, Manhattan 66506
B. A. Koch, R. H. Hines, G. L. Allee, and R. I. Lipper
Managing Livestock wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 181-183.

Descriptors: Aerobic treatment.
Identifiers: Swine, Foaming, Maintenance, Aerob-A-Jets, Land disposal, Holding tanks.

Aerobic oxidation was the method of waste disposal built into new swine production facilities at K.S.U. in 1968. The system has been used continuously and is functioning successfully. A 29-stall farrowing house sits over a racetrack pit 80 feet long (one side) by 8 feet wide and 4 feet deep (the septic tank from the headquarters building drains directly into this pit). The nursery sits over two similar pits each 80 feet by 4 feet wide and 4 feet deep. Each of two finishing barns sits over a racetrack pit 194 feet long (one wide) by 8 feet wide and 4 feet deep. Liquid level is maintained constant in each pit by a standpipe which drains into an outside holding tank. Holding tank fluid is hauled to farm fields with a tractor and a liquid manure wagon. The pits were originally equipped with paddle wheels, but foaming and maintenance problems led to the installation in late 1971 and early 1972 of Fairfield Aerob-A-Jets. At that time pits in the finishing barns were drained and cleaned because of excessive build-up of solids. Pits in the farrowing house and nursery have never been cleaned except for fluid that overflows from the standpipe. Data collected since the installation of the "Jets" includes: power consumption, fluid temperature, fluid pH, fluid dry matter, dry matter composition, and amounts of fluid overflowing from the pits. Records show that maintenance of "Jets" has been minimal. Observations indicate that odor levels were low and recently have been reduced almost to zero by daily use of small quantities of a commercial product (Puritan Live Microorganisms) in each pit. (Koch, et. al.-Kansas State University; Merryman, ed.)

### 2638 - A1, B1, D4 200

### TWO-STAGE ACTIVATED SLUDGE TREATMENT OF EFFLUENT FROM INDUSTRIAL HOG BREEDING FARMS,

Institute for Water Management, Bucharest, Spl. Independentei 294, Romania
C. A. L. Negulescu

Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 184-185.

Descriptors: Activated sludge, Waste treatment.
Identifiers: Swine, Romania.

One of the problems which may be solved by the activated-sludge process is the treatment of effluents from industrial hog breeding farms. During the last years, Romania has applied the system to breed hogs on a large number of capita on a very limited area (structures of agro-industrial type amounting 100-150 thousands hogs). Since the waste disposal by land-spreading requires a large agricultural area, the possibility to treat and dispose the waste has been taken into consideration. Our studies started with the characterization of wastes; the results obtained have been given as specific load (per capita). After few treatment plants built on mechanical and natural-biological treatment, the severe discharge conditions in some parts of the country obilged us to try more efficient methods of treatment. The conventional methods used in sewage treatment have been tried with good results. On laboratory scale (1970) and on full-scale (1972-73) we tried the hog waste settling followed by two stage activiated-sludge treatment. The results were very hopeful (more than 95 per cent efficiency) and upgrading these first plants, we hope to improve them. (Negulescu-Romania)

2639 -A1, B1, C5, D3, D4, E2 200

### A PIG SLURRY TREATMENT SYSTEM BASED ON SEPARATION BEFORE AEROBIC TREATMENT AND SLUDGE DE-WATERING,

Farm Buildings Department, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Bedford, England
R. Q. Hepherd and L. E. Osborne
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 186-189

Descriptors: Slurries, Separation techniques, Aerobic treatment, Dewatering.
Identifiers: Swine, England, Land disposal, Flocculants.

The aim of the research was to convert pig slurry into liquids or solids that were easy and cheap to store and to apply efficiently to land without causing air or water pollution problems. The stages of treatment were: separation to produce a fibrous solid and a free-flowing liquid; treatment by high-rate biological filtration; settlement to produce a wet sludge; gravity filtration of the wet sludge after addition of a flocculant to produce a stackable sludge and a relatively clean filtrate. A continuously-operated pilot plant was developed, all inputs to and outputs from the treatment stages being automatically controlled. Only the separator and surplus filtrate disposal system were manually controlled. For a 6-month period, the plant was fed with 1800 liters of slurry from slatted-floor housing. The plant proved simple to operate, very reliable, and required about 1 man-hour day for servicing and removal of products to store. The filtrate was a straw coloured liquid containing less than 10g-1 BOD$_5$ and 1.5g-1 suspended solids. A mathematical model of the system incorporated into a 500-pig slatted floored fattening house suggested that the quantity of filtrate for disposal to land would be substantially less than for the pilot plant. There were no objectionable smells from the end products. A design for a mechanically-ventilated piggery in which the ventilation and waste treatment systems are integrated has been completed, the objectives being to scrub the exhaust ventilating air and at the same time keep the liquid warm. Apart from removal of the end products, the system will be fully-automatic. (Herpherd-England; Merryman, ed.)

2640 - B2, D4, E3 200

### OXIDATION DITCH WASTE MANAGEMENT SYSTEM FOR A LARGE CONFINEMENT SWINE FARM,

Farm owner, Box 26, Lawrence, Kansas 66044
P. Smart, F. McCain, D. L. Day, and B. G. Harmon
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 190-191.

Descriptors: Kansas.
Identifiers: Oxidation ditch, Swine, Evaporation ponds, Slatted floors.

This is a case study of the complete waste management system of the Paul Smart confinement swine farm near Lawrence, Kansas. The intensive confinement enterprise is located on only 24 acres. All feed is brought in pre-prepared from an off-farm commercial feed processing center. At present, the farrow-to-finish enterprise has 150 farrowing stalls producing 15,000 market hogs per year. There are 5 full-time people involved in the husbandry-management of the total enterprise. Oxidation ditches beneath slotted floors have been used since the farm began. Surplus waste materials overflow from the oxidation ditches into evaporation ponds. There is no other waste management used, such as scraping, scooping, hauling, etc. The 11 buildings and 37 rotors are distributed as follows: 3 sow housing—8 rotors; 3 farrowing—3 rotors; 2 nursery—4 rotors; 1 growing—2 rotors; 2 finishing—20 rotors. The rotors, developed under cooperation with Ross E. McKinney of the University of Kansas Civil Engineering Department, are 36 inches wide by 60 inches in diameter and are powered by 5-hp motors. They are performing well with a low level of maintainance problems. The total electricity bill including that for rotors, feeders, and lights has been about $1.00 per hog marketed. The farm management is pleased with the low-odor low-labor method of swine waste management. A method of refeeding aerobically processed wastes is being tested. (Smart, et. al.-Kansas; Merryman, ed.)

2641 - B3, C3, D1, E3 200

### RECOVERY OF NUTRIENTS FROM ANIMAL WASTES–AN OVERVIEW OF EXISTING OPTIONS AND POTENTIALS FOR USE IN FEED,

USDA, Beltsville, Maryland
R. G. Yeck, L. W. Smith, and C. C. Calvert
Managing Livestock Waste, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 192-194

Descriptors: Nutrients, Animal wastes, Feeds, Recycling, Costs, Economics, Constraints, Fermentation, Separation, Dehydration.
Identifiers: Refeeding, Controlled storage.

Processes for the recovery of nutrients from animal wastes can contribute to reduction of solid waste disposal problems, reduction of livestock production and consumer product costs, increase feed supplies and conserve natural resources. The economics of livestock production today provides the greatest immediate incentive for adoption of such processes by livestock producers. Several systems have been researched for recovering nutrients from wastes. A system is composed of resource material, process, and intended use. The resource-animal wastes contain varying quantities of nutrients including protein, energy, phosphorus and other nutrients. Processes include aerobic and anaerobic fermentation, physical separation, dehydration and heat treatment, and controlled storage. Resulting products have been tested in diets of animals for maintenance and various productive functions performance. Several systems are now in successful use. There are constraints to implementation of the various systems. These constraints include animal acceptibility, utility, animal product safety and consumer acceptance. It is anticipated that this review will provide livestock producers information to assist in identifying those systems most applicable to their needs. (Yeck, et. al-USDA)

2642 - B1, C1, D4, E3 200

### ENSILING POULTRY FLOOR LITTER AND CAGE LAYER MANURE,

Georgia University, Athens
S. A. Vezey and C. N. Dobbins, Jr.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, p. 195-196.

Descriptors: Poultry, Litter, Analysis, Waste treatment, Recycling.
Identifiers: Ensiling, Cage layer manure, Lactobacillus acidophilus.

The objective of this project was to develop a method of ensiling cage layer manure as an alternate to drying. The physical characteristics of the raw waste product prohibits mechanical handling by the usual methods of processing ensilage. Exploratory trials using varying mixtures of floor litter, corn, cage layer manure, dried molasses, and Lactobacillus acidophilus culture (to accelerate fermentation) were conducted for ensiling and physical characteristics. These trials indicated that the ratio of these ingredients which provided a method for ensiling cage layer manure as a feed for ruminants was: 50 lbs. ground corn, 20 lbs. floor litter, 30 lbs. cage layer manure, 7.5 lbs. dried molasses (absorbed on soybean mill feed), and lbs. Lactobacillus acidophilus culture titering $10^{-6}$ to $10^{-8}$, and water q.s. to bring total moisture to 40-45 per cent. The results indicate that the addition of Lactobacillus acidophilus and molasses reduced the ensiling time to 4 weeks or less. Analyses for crude fiber, protein, fat, and moisture were replicated on three lots. The data obtained varied less than 0.5 per cent except moisture which ranged from 44.10 per cent to 45.73 per cent. Values for the above were: CF 11.0 per cent, protein 15.56 per cent[1], fat 1.40 per cent. Analyses to delineate mineral and amino acid compositions were also done. Aerobic anaerobic cultures were negative for pathogenic bacteria. Controlled feeding trials have not been conducted, but uncontrolled studies have demonstrated acceptable palatability of the ensilage for ruminants. To make a complete and balanced ration, appropriate vitamin and mineral supplements are necessary. Energy levels can be adjusted by additives to meet desired specifications. (Vezey and Dobbins-Georgia University; Merryman, ed.)

2643 - B1, D4, E3 200

### RECYCLING SOLIDS FROM AN AERATED BEEF SLURRY FOR FEED,

Minnesota University, St. Paul
R. O. Hegg, R. E. Larson, J. A. Moore, R. D. Goodrich, and J. C. Meiske
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 197-198.

Descriptors: Aerobic treatment, Slurries, Cattle, Recycling, Feeds, Performance, Energy.
Identifiers: Refeeding, Oxidation ditch, Finishing rations.

Reclaimed solids from an oxidation ditch receiving beef wastes were fed at three rates, 5, 15, and 25 per cent of the ration on a dry matter basis to finishing steers to evaluate this material as a ration component. The 3 reclaimed solids rations plus a high energy control ration were fed to four pens of steers in the 4 month feeding trial. The animals over the oxidation ditch were receiving a ration containing 90 per cent corn plus supplement and were a different group of steers than those on the refeeding study. The conclusions were: (1) The reclaimed solids, collected on a 22 mesh screen, had approximately 50 per cent the feeding value of corn on a dry matter basis. (2) Feed consumption decreased as the percentage of reclaimed solids in the ration increased. (3) The cattle needed a period of several days to adjust to the ration before they would readily consume the animal waste solids. Perhaps some processing of the material would decrease or eliminate this period. (4) The lower energy of the reclaimed solids, would probably make it more suitable in maintenance rations than in finishing rations. (Hegg, et. al.-Minnesota University)

### 2644 - B2, C5, D4, E3 200

### NUTRIENT AVAILABILITY FROM OXIDATION DITCHES,

Department of Animal Science and Department of Agricultural Engineering, respectively, University of Illinois, Urbana
B. G. Harmon and D. L. Day
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 199-202.

Descriptors: Nutrients, Aerobic treatment, Farm wastes, Proteins, Nitrogen.
Identifiers: Oxidation ditch, Refeeding, State of the art.

This is a state of the art paper that discusses the nutrient content of products of aerobically treated waste and the results of feeding this nutrient source to swine as well as laboratory animals. The paper summarizes publications by the authors and other researchers spanning the past six years. In addition, on-the-farm experiences of swine producers in the midwest United States that have refed the bioenhanced swine waste will be included. The objective of the paper is to discuss the potential and limitations of producing single-cell protein for animal feeding from the contents and in the environment of oxidation ditches and other methods of aerobic treatment. The nitrogen excretory products are incorporated into amino acids and thus become the more important nutrients contributed by the nutrient solution. The oxidation ditch mixed liquor is also rich in minerals and water soluble vitamins. The topics discussed include: (1) Essentiality of maintaining a highly aerobic environment. (2) Amino acid concentration changes occurring in contents of the oxidation ditch. (3) Increase in total nutrient contribution by enhancement of fresh waste to oxidation ditch mixed liquor. (4) Increase with time in ash, the only nonbiodegradable component in the oxidation ditch. (5) Performance of swine fed products of the oxidation ditch. (6) Discussion of practical systems for feeding liquor from the ditches currently in use on swine farms. (7) Discussion of liquids balance demonstrating waste usage by the pigs in excess of liquid available from the oxidation ditch. (8) Potential for establishing a waste treatment system with no overflow. (Harmon and Day-Illinois Univ.)

### 2645 - A9, E3 200

### NUTRITIONAL, PATHOLOGICAL AND PARASITOLOGICAL EFFECTS OF FEEDING FEEDLOT WASTE TOO BEEF CATTLE,

Department of Animal Science, Oklahoma State University, Stillwater
R. R. Johnson, R. Panciera, H. Jordon, and L. R. Shuyler
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 203-205.

Descriptors: Nutrition, Pathology, Parasitism, Performance, Cattle, Feeds.
Identifiers: Dried beef feedlot waste, Refeeding.

Twenty-four beef calves were randomly allotted by weight and sex to 8 pens. Two pens were fed rations containing 85 per cent concentrate plus (1) 15 per cent cottonseed hulls (CSH), (2) 15 per cent dried beef feedlot waste (FLW), (3) 5 per cent CSH+10 per cent FLW or (4) 5 per cent CSH+5 per cent FLW (without protein supplement). Animals were weighed semimonthly. After 91 days on feed, average daily gains in kg. per day were 1.2, 0.7, 1.0 and 0.8 for treatments 1, 2, 3, and 4, respectively. Kg. feed required per kg. gain were 7.2, 11.2, 7.9, and 9.6, respectively. Daily feed consumption at the beginning of the trial was very poor for the groups fed FLW rations but recovered by the end of the trial. Although, FLW did not appear to be a satisfactory substitute for CSH as a roughage source or for the protein supplement, the data were confounded by feed consumption differences. After 91 days on feed, all animals were sacrificed for pathological and parasitological observations. No significant effects due to FLW consumption were observed in the gross or histological pathology of the rumen wall, abdominal wall, intestinal wall, lung, kidney, liver, spleen, trachea, or adrenals. Bile samples from all animals were negative for salmonella. The internal parasite burden (stomach and intestinal worms) was extremely low and not different due to FLW consumption. (Johnson, et. al.-Oklahoma)

### 2646 - A9, C5, D2 200

### MICROBIOLOGICAL AND CHEMICAL ANALYSES OF ANAPHAGE IN A COMPLETE LAYER EXCRETA IN-HOUSE DRYING SYSTEM,

Department of Poultry Science, Michigan State University, East Lansing 48824
T. S. Chang, J. E. Dixon, M. L. Esmay, C. J. Flegal, J. B. Gerrish, et. al.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 206-207.

Descriptors: Analysis, Microbiology, Moisture content, Chemical properties, Proteins, Calcium, Phosphorus.
Identifiers: Anaphage, Dehydrated cage layer excreta, In-house drying system, Ash, Fiber, Ether extract.

Anaphage (dehydrated cage layer excreta), from a complete in-house drying system, was analyzed microbiologically to determine the microbial population and surviving species. The results indicated that the microbial population was closely related to the moisture content of the anaphage. Only a few species of microorganisms survived the dehydration process. Chemical analyses were also performed on the anaphage from this drying system. Crude protein of the anaphage was measured at 36.50 per cent and corrected protein at 16.41 per cent. The results of the chemical analyses of anaphage on calcium, phosphorus, ash, fiber and ether extract will be reported. (Chang, et. al.-Michigan State University)

### 2647 - A1, D1, E3 200

### NUTRITIONAL PROPERTIES OF FEEDLOT MANURE FRACTIONATED BY CERECO PROCESS,

Department of Animal Sciences, Colorado State University, Fort Collins 80523
G. M. Ward, D. E. Johnson, and E. W. Kienholz
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 208-210

Descriptors: Nutrition, Recycling, Feeds, Feedlots, Cattle, Poultry, Rainbow trout, Performance.
Identifiers: Refeeding, Cereco protein product, Fractionated manure.

Ceres Ecology Corporation has developed equipment which produces three feedlot manure fractions: high fiber silage, dried protein product, and high ash residue. Nutritional studies of the first two products were conducted with cattle and poultry. The Cereco protein product (C-II) was first fed as 0, 5, 10, or 15 per cent of the ration to day-old broiler chicks. Five percent increased gains slightly. Ten and fifteen per cent depressed gains and feed conversion slightly. This C-II contained 21.0 per cent protein but 40.4 per cent ash which diluted the energy density of the ration. In a second trial C-II containing 21.6 per cent protein and 28.6 per cent ash was compared at the 5, 10, or 20 per cent level of the broiler ration. C-II at the 5 or 10 per cent level produced greater weight gains. Equal gains resulted at 20 per cent. A C-II product containing 23 per cent protein and 33 per cent ash was fed as 0, 15, or 30 per cent of the ration for laying hens for six weeks. Both 15 or 30 per cent substitution maintained the same egg production, egg quality, and body weight. The energy value was determined to be 500 kcal of metabolizable energy per kg. The replacement value of C-II in these rations was calculated to be almost $150 per ton. C-II was fed as 14 per cent of the diet of young rainbow trout and gains were essentially the same as the control diet. Older trout received C-II as 14 per cent of diet and had gains of 1 or 2 per cent less than controls. In no case was mortality or morbidity increased. C-II fed to steers resulted in digestibility and nitrogen retention of about 80 per cent of the value obtained with a soybean meal supplement. Cereco silage was fed to 10 Hereford steers to determine digestibility and feed energy value, and compared with corn silage. The composition of Cereco silage and digestibility respectively was dry matter 34.4, 50.3; protein 9.0, 56.5; crude fiber 27.5, 65.3; ether extract 1.8, 90.6, and nitrogen-free extract 50.4, 67.1 per cent. The total digestible nutrient (TDN) content was 60.2 per cent compared to 65.2 per cent for the corn silage used for comparison. The net energy value for maintenance and gain were respectively 1.78 and 1.51 m cal/kg. (Ward, et. al.-Colorado State University; Merryman, ed.)

### 2648 - B1, E3 200

### NUTRITIONAL VALUE OF CATTLE FEEDLOT WASTE FOR GROWING-FINISHING BEEF CATTLE,

Department of Animal Science, Texas Tech University, Lubbock
R. C. Albin and L. B. Sherrod
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 211-213.

Descriptors: Nutrition, Feedlots, Cattle, Southwest U.S., Digestibility, Waste disposal.
Identifiers: Composting, Ground beef feedlot waste, Refeeding.

An attempt was made to determine the nutritive value of feedlot wastes from cattle in the Southwestern United States. Specific objectives were to determine the effect of feeding different levels of beef feedlot waste (FLW) to growing-finishing beef cattle upon acceptability and digestibility; and to determine the effect of the physical form of FLW upon its nutritive value for growing-finishing cattle (composted waste versus dry, ground waste). A one-month collection of FLW was ground through a hammer mill. Rations containing FLW were offered to feeder steers in 3 total collection, digestion trials for 28 days each. Trial I substituted ground FLW at 0, 20, 40 and 60 per cent levels into high-energy finishing ration with adequate protein. Trial II involved composting the FLW, then using similar amounts as in Trial I. Trial III involved the feeding of raw and composted FLW at a 40 per cent level in a low-energy, low-protein ration, resembling a high-roughage growing ration. Each ration was offered to 5 steers. Steers readily consumed rations containing as much as 60 per cent ground FLW, but with a significant linear reduction in ration digestibility. FLW in a low energy-low protein ration significantly decreased ration digestibility. Little difference was observed between raw and composted waste. Nutritional advantage would not be gained by feeding ground FLW to growing-finishing beef cattle, nor would it appreciably improve the waste disposal problem of commercial cattle feedlots. (Albin and Sherrod-Texas Tech; Merryman, ed.)

## 2649 - E3 200
## NUTRITIVE VALUE OF SWINE FECES FOR SWINE,

Department of Animal Science, Virginia Polytechnic Institute and State University, Blacksburg
M. R. Holland, E. T. Kornegay, and J. D. Hedges
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 214-217.

Descriptors: Nutrients.
Identifiers: Refeeding, Swine, Absorbed dry matter, Crude protein, Crude fiber, Ash, Ether extract, Nitrogen free extract.

Twenty-four cross bred gilts weighing about 125 kg were randomly allotted to 3 dietary treatments in an experiment for determining the nutritive value of swine manure fed to swine. Rations containing 0, 24, and 34 per cent (dry basis) were made by substituting fresh manure for equal parts of a 15 per cent corn-soybean meal ration. The rations were fed at either 1.4 or 1.8 kg per gilt per day. The absorbed dry matter (ADMPI), crude protein (ACPPI), crude fiber (ACFPI), ash (AAPI), ether extract (AEEPI), and nitrogen free extract (ANFWPI) as a per cent of intake significantly decreased as manure intake increased. Retained N as a per cent of intake (RNPI) was significantly decreased as manure intake increased; however, retained N as a per cent of absorbed (RNPA) was not significantly decreased. Increased manure intake caused a significant decrease in absorbed (ACaPI) and retained Ca (RCaPI) as a per cent of intake, retained P as a percent of absorbed RPPA, and absorbed K as a per cent of intake AKPI. There were no significant changes in retained CA as a per cent of absorbed (RCaPA), absorbed (APPI) and retained P (RPPI) as a per cent of intake, absorbed Mg as a per cent of intake (RMgPI), retained Mg as a per cent of absorbed (RMgPA), absorbed Cu (CuPI) and absorbed Zn (AZnPI) as a per cent of intake. Based on regression analysis, the extrapolated values of the following criteria for manure were (per cent): ADMPI 52.7, ACPPI 62.9, ACFPI 52.6, AAPI 36.9, AEEPI 63.4, ANFEPI 77.9, RNPI 18.8 and RNPA 31.1. The extrapolated values for the mineral criteria for manure were (per cent) ACaPI 24.8, RCaPI 24.6, RCaPA 99.3, APPI 31.0, RPPI 29.8, RPPA 95.8, AMgPI 25.0, RMgPI 24.6, RMgPA 98.1, ACuPI 15.2, AKPI 70.9 and AZnPI 20.5. Substitution of a basal corn soybean meal ration with fresh swine manure decreased the quality of the ration. (Holland, et. al.-Virginia; Merryman, ed.)

## 2650 - C3, D2, E3 200
## THE INCLUSION OF PIG MANURE IN RUMINANT DIETS,

School of Agriculture and Forestry, Melbourne University, Parkville, Victoria, Australia
G. R. Pearce
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 218-219.

Descriptors: Diets, Cattle, Chemical properties.
Identifiers: Refeeding, Swine, Dried pig manure, Australia, Digestibility, Nitrogen retention, Copper balance.

The potential for recycling livestock waste with respect to Australian conditions are discussed briefly. In many areas the economic disposal of wastes from intensive piggeries poses the greatest problem. The results of experiments conducted by the University of Melbourne, Victoria, using pig manure are described: (1) The composition of pig manure from different sources (including contents of a number of mineral elements). (2) The utilization of dried pig manure by cattle when fed at 0, 15, 30 and 45 per cent of the diet (digestibility, nitrogen retention, copper balance). (3) Some effects of feeding dried pig manure, at 30 per cent of the diet, continuously to cattle over a period of about 8 weeks. (4) The utilization of dried pig manure by sheep when fed at 0, 15 and 30 per cent of the diet; attempts to prevent copper toxicity by additions of molybdenum. (Pearce-Melbourne University)

## 2651 - A9, B3, D2, E3 200
## A SUMMARY OF REFEEDING OF POULTRY ANAPHAGE, MORTALLITY, RECYCLING HENS, AND EGG PRODUCTION,

Department of Poultry Science, Michigan State University, East Lansing 48824
C. J. Flegal, H. C. Zindel, C. C. Sheppard, T. S. Chang, et. al.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 220-221.

Descriptors: Mortality, Recycling, Dehydration, Health, Diseases.
Identifiers: Refeeding, Poultry anaphage, Egg production, Waste management, Marek's Disease, Lymphoid Leukosis.

The Environmental Protection Agency project at Michigan State University, entitled "Demonstration of the Handling, Dehydrating, and Utilization of Poultry Excreta" involved the purchase of 5000 twenty-week old, ready-to-lay, pullets. The birds came into production at the normal rate but soon displayed symptoms of several diseases, including Marek's and Lymphoid Leukosis. Inasmuch as production of excreta was the key criteria, normal egg production was assumed to be satisfactory. However, as the project progressed, the death loss mounted and health treatments as recommended by personnel of the College of Veterinary Medicine had no effect. Additional birds were bought to bring the population back to 5000 birds but these additions had little or no effect on production figures. Recycling birds (molting) had no positive effect on egg production. Fecal production continued at a normal rate. Poultry anaphage was fed to one-half the bird population at the rate of 10 per cent. (Flegal-Michigan State University)

## 2652 - A9, C4, D4, E3 200
## ENSILING BROILER LITTER WITH CORN FORAGE, CORN GRAIN AND WATER,

Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061
J. P. Fontenot, L. F. Caswell, B. W. Harmon, and K. E. Webb, Jr.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 222-226.

Descriptors: Poultry, Litters, Feeds, Bacteria, Coliforms, Fermentation.
Identifiers: Ensiling, Refeeding.

Ensiling is a potentially valuable processing method for destruction of pathogens in animal waste. Experiments were conducted to study the feasibility of ensiling broiler litter with corn forage, high-moisture corn grain and added water. All ensiling was in sealed polyethylene bags. Broiler litter was ensiled with corn forage harvested when it contained 30-40 per cent dry matter. The levels of litter were 0, 15, 30 and 45 per cent dry basis in small laboratory silos (2 kg) snf 0, 15 and 30 per cent in larger silos. Small silo silages were studied for fermentation characteristics. Large silo silages were studied for metabolism and palatability as well. All mixtures preserved well and showed favorable fermentation characteristics. High levels of broiler litter increased total bacteria in silage, though coliforms were lower. Addition of litter increased crude protein in silages. Silage pH varied from 3.6 to 4.7 and tended to be higher in silages containing broiler litter. Apparent digestibility of crude protein was increased by addition of litter to corn forage. Nitrogen retention was greater for sheep fed silages containing broiler litter, indicating that the litter nitrogen was utilized. Addition of litter to corn forage increased dry matter intake by ruminants. (Fontenot, et. al.-Virginia Polytechnic Institute and State University; Merryman, ed.)

## 2653 - A1, A7, C5, D3, E3 200
## CONVERSION OF ANIMAL WASTES TO FEED SUPPLEMENTS VIA THE ORGANIFORM PROCESS,

Orgonics, Inc., Slatersville, Rhode Island
C. K. Davies, G. A. Varga, and R. S. Hinkson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 227-229.

Descriptors: Organic wastes, Fertilizers, Feeds, Cattle, Performance, Research and development.
Identifiers: Refeeding, Organiform.

Since the Organiform process is already being successfully applied commercially, its application to the animal waste problem and other organic wastes is timely and does not require massive research and development to meet the EPA feedlot waste deadlines. Organiform, a process developed by Orgonics, Inc. of Slaterville, Rhode Island, is a trade name given to a series of products resulting from reaction of and the proteinaceous constituents of many organic wastes. The Organiform process is based on the reaction of urea and formaldehyde to form methylol ureas. These highly biocidal compounds effect sterilization of Organic waste and after addition of a catalyst, a methylenization reaction brings about conversion of the waste material to an entirely new entity, which is sterile, stable, and in most cases, odorless. Since the resulting Organiform products showed such excellent fertilizer properties, and the chemical nature of the products were well assimilated by soil bacteria, the Organiform process seemed applicable to cattle manure, and the resulting product (Organiform CM) was evaluated as a high nitrogen feed supplement. The cattle manure was processed in the form of a slurry and resulting Organiform CM was added to ground corn and dried to form a pre-mix which was incorporated into a total diet. Preliminary data obtained with dairy heifers and two rumen-fistulated Holstein steers indicate that feed containing Organiform CM, at a level to provide 31 per cent of the crude protein, was readily acceptable and palatable. All animals made respectable body weight gains. (Davies, et. al.-Rhode Island; Merryman, ed.)

## 2654 - A9, C5, D4, E3 200
## HEALTH ASPECTS OF FEEDING ANIMAL WASTE CONSERVED IN SILAGE,

Department of Animal and Dairy Sciences, Auburn University, Auburn, Alabama
T. A. McCaskey and W. B. Anthony
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 230-233.

Descriptors: Performance, Salmonella, Silage, Coliforms.
Identifiers: Refeeding, Health, Cattle manure, Ensiling.

Animal waste harvested from the feeding floor of confined reared cattle has been blended with various feed ingredients and stored as silage prior to feeding. Extensive tests show that common feed ingredients containing sufficient carbohydrates to support an acid microbial fermentation can be blended with manure to make an effective animal feed. A balanced complete feed mixture (basal) was blended 1.5:1 with wet animal waste, stored in a silo, and fed to yearling cattle to produce the same rate of animal performance as obtained when the basal ration was fed alone. In all tests, animal waste had appreciable feed replacement value. A study was conducted with 27 Salmonella cultures inoculated ($66x\ 10^6$ cells/g) into manure-containing feed and into the manure used to prepare the feed. None of the cultures were recovered from the feed mixture after 3-day ensiling at 25 degrees C; whereas, 25 of the Salmonellae cultures were recovered from the inoculated manure under similar conditions. Manure with a pH of 6.0 to 6.5 prior to inoculation permitted 25 cultures to survive 3 days; whereas, no cultures survived in manure with an initial pH of 4.0 to 4.5. The ensiling temperature had a pronounced effect on Salmonellae survival. With an improved recovery technique, 21 of the 27 Salmonellae were recovered from feed ensiled 4 days at 5 degrees C, 25 from feed ensiled at 15 degrees C, one at 25 degrees C, and none at 35 degrees C. The pH of the feed ensiled at 25 degrees or 35 degrees was lower than for ensiled feed held at 5 degrees or 15 degrees C. The coliform count decreased from approximately $1 \times 10^6$/g at 5 degrees C. (McCaskey and Anthony-Auburn University; Merryman, ed.)

### 2655 - A1, B1, D4, E3, F1 200

### START-UP OF PILOT SCALE SWINE MANURE DIGESTERS FOR METHANE PRODUCTION,

Professor, Department of Agricultural Engineering, University of Manitoba, Winnipeg, Manitoba, Canada
H. M. Lapp, D. D. Schulte, E. J. Kroeker, A. B. Sparling, and B. H. Topnik
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 234-237.

Descriptors: Research and development, Canada, Methane, Anaerobic treatment, Design criteria, Economics.
Identifiers: Swine, Environmental impact.

A three-phase program including bench-scale studies, pilot plant operation and full farm scale anaerobic treatment of swine waste was initiated in 1971 to evaluate the technical and economic feasibility of the process in Manitoba, particularly during cold winter temperatures. Specific objectives of the project were to: (1) complete a preliminary evaluation of the economics of anaerobic digestion as a process for recovering energy from livestock wastes; (2) determine the design parameters for methane gas production from animal wastes in cold climate regions representative of Manitoba and Canada; (3) develop simple, safe and economical methods of collecting, purifying, storing and utilizing methane on livestock farms; (4) analyze the effluent and assess its value as a fertilizer and (5) assess the environmental impact, if any, of the anaerobic digestion process. Results of bench-scale, initial and recent winter operation of the pilot plant are discussed in relation to project objectives. Problems associated with purification, handling, and storage of methane together with experience gained in the operation of a one-half ton pick-up truck equipped to operate on methane are outlined. (Lapp, et. al.-Canada; Merryman, ed.)

### 2656 - B1, D4, E3 200

### SMALL METHANE GENERATOR FOR WASTE DISPOSAL,

Specialist, Joint Commission on Rural Reconstruction, Taipei, Taiwan
C. Po, H. H. Wang, S. K. Chen, C. M. Hung, and C. I. Chang
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 238-240.

Descriptors: Methane, Recycling, Design, Fertilizers, Energy.
Identifiers: Swine, Taiwan, Construction materials.

Taiwan produces 6 million pigs a year, most of which are kept in small "family" units, and frequently "Manure Credit" is the only profit in pig raising. In the traditional way of compost making, much of the nitrogen is lost in the form of ammonia. In an effort to improve the fertilizing value of the manure and, at the same time, to produce some fuel gas therefrom, small simple methane generators costing $300 each have been developed and widely extended in Taiwan. The generator consists of an excavated brick digester of 5' x 5' x 6' and an inverted steel gas holder of 6' x 6' x 3' resting in the water seal. The digester is connected to the pigsty by a cement pipe through which the wastes and sewage of 10-15 hogs are fed daily, and the production of gas is continuous. The gas contains 63-67 per cent $CH_4$, 27-33 per cent $CO_2$ and 1.7 per cent $H_2S$. The hydraulic retention time is estimated at 5-10 days. Under the subtropical conditions, the gas produced is about 3,000 liters a day, which is enough for cooking three meals for a family. When used for the generation of electrical power, the gas is enough to run a 4-HP Kohler engine for operating a 2-KW generator for 3 hours a day. Experiments are underway to find alternative construction materials, such as rubber bag, PVC-impregnated mud plate and fiber glass gas holder to lower the cost so that the digesters can be commercialized. Oxidation ditches are also built beside the digester for further disposal of swine wastes. (Po-Taiwan)

### 2657 - D2, E3, E4 200

### PRODUCT APPLICATIONS OF TREATED LIVESTOCK WASTE,

Materials Department, School of Engineering and Applied Science, California University, Los Angeles
C. Corvino, B. Dunn, E. Tseng, and J. D. Mackenzie
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 241-243.

Descriptors: Recycling, Pigments, Feedlots, Cattle.
Identifiers: Pyrolysis, Swine, Carbon content, Filler, Building materials.

Cattle and hog manures have been pyrolyzed at fairly low temperatures yielding solid and gaseous by-products. The volatile fraction is condensed in two stages. An aqueous portion is collected at lower temperatures (100 degrees C or so). The nitrogen-rich liquid holds promise as a fertilizer. At greater temperatures, a low sulfur crude oil is condensed for cattle manure. The sulfur and nitrogen contents are fairly low. Chemical analyses of these liquids are presented for manure samples of different feedlots. Uncondensed vapors are combustible. Hog manure yields a wax-like product rather than oil. The pyrolyzed product is a black carbonaceous aluminosilicate solid. The material has been successfully substituted for carbon black in such products as printing ink, paint and rubber where the treated manure serves as a pigment and filler. The properties of these materials are described. The carbon content is controllable from temperature and rate of pyrolysis. One very promising application of the pyrolyzed solid is in combination with glass. High quality tiles have been made whose properties, in many cases, are superior to currently marketed products. The fabrication process and resulting properties are presented. Economic analyses for the production of treated manure and the manufacture of certain products are given. (Corvino, et. al.-California University; Merryman, ed.)

### 2658 - D4, E3 200

### CHARACTERIZATION OF METHANE PRODUCTION FROM POULTRY MANURE,

Department of Microbiology, Maine University, Orono
H. M. Hassan, D. A. Belyea, and A. E. Hassan
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 224-247.

Descriptors: Methane, Anaerobic digestion, Energy, Feed, Poultry.

Laboratory scale digesters of different sizes were designed to study the optimum conditions and the kinetics for methane production. Fresh manure (28-35 per cent solids) from caged layers was used. The results indicated that solids content of 6.5-6.75 per cent provided the highest gas production, and the methane content reached 87 per cent for a retention period of 30 days. 130 liters of methane per kilogram of dry manure solids were produced at 6.74 per cent solids concentration. A relationship between sludge solid content and retention period was established. 50-70 per cent reduction in solids contents of the completely digested effluents was achieved. The presence of exogenous carbon (2-8 per cent) in general increased the total production of methane gas. The rate of gas production was to the size of inoculum used. The volatile acid content of the effluent increased, then declined as the percentage of methane in the evolved gas reached maximum. The gas produced contained 6 PPM hydrogen sulfide, sufficient to give a distinct odor. The methanogenic bacteria predominately presented in the system were Methanobacterium sohngenii and Methanobacterium omelianskii. A 600 gallon demonstration unit was designed and operated on a batch basis, using the results of the laboratory scale digesters, in order to test the control and feed mechanisms for a future full scale system application. The daily gas production from the 500 gallon sludge increased from 8 ft after mixing to $40\ ft^3$ with the gas methane content approaching 82 per cent, then declined indicating that partial recharging with predigested manure was required. (Hassan, et. al.-California University; Merryman, ed.)

### 2659 - D3, 200

### SEPARATING NUTRIENTS TO ENHANCE SWINE-WASTE DIGESTION,

Associate Professor of Civil Engineering, Department of Civil Engineering, Kansas State University, Manhattan
L. A. Schmid, R. I. Lipper, J. K. Koelliker, C. A. Cate, and J. W. Daber
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 248-251.

Descriptors: Anaerobic digestion, Methane, Fertilizers.
Identifiers: Swine, Nutrient separation, Ammonium phosphate.

Total confined feeding of livestock results in the capture of all wastes, urine, and feces, resulting in a very high nitrogen waste. Anaerobic digestion and biological stabilization is often hampered due to toxicity caused by ammonium buildup. This has resulted in the need to add dilution water, increasing the waste volume and consequently the disposal costs. This project was designed to explore a novel method of waste treatment that would reduce the toxic ammonium, increase waste stabilization and methane gas production, eliminate need for dilution water, reduce volume for ultimate disposal to land and produce a clean liquid ammonium phosphate fertilizer. The test facility consists of an eight foot cubed anaerobic digester serving 120 swine. Sealed gas blowers collect the gas from the digester and pass it through a phosphoric acid column for removal of ammonia and conversion to ammonium phosphate. It then passes through a potassium hydroxide column for removal of carbon dioxide. The cleaned methane gas is recycled to the digester for further mixing and gas stripping with the excess clean gas burned and used for digester heating. Carbon dioxide must be removed to maintain the digester equilibrium pH near 8. Because of digester detention times of 15 to 20 days ammonia can be reduced at these pH values. Gas recirculation rate is approximately 50 cfm. per 1000 cu. ft. of digester volume. Design and operational recommendations, with seven months of field data, are presented along with the proposed economics of a large scale system. (Schmid, et. al.-Kansas State University)

### 2660 - A1, E2 200

### RESIDUAL AND ANNUAL RATE EFFECTS OF MANURE ON GRAIN SORGHUM YIELDS

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A. C. Mathers, B. A. Stewart, and J. D. Thomas
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 252-254.

Descriptors: Fertilizers, Crop response, Grain sorghum, Feedlots, Nitrates, Salts, Soil profiles.
Identifiers: Land disposal, Application rates.

The effect of varying rates of feedlot manure on irrigated grain sorghum (*Sorghum bicolor*) production has been studied for 5 years. The treatments were 0, 22, 67, 134, and 268 tons per hectare (T/ha wet weight, approximately 50 per cent water) applied annually. Other treatments were 538 T/ha applied the initial year only and 538 t/ha for the initial three years. Commercial fertilizer plots were also included for comparison. All treatments were replicated three times in level borders and irrigated equally as necessary to support good crop growth. Soil analyses were made at seeding time to determine the soil salinity and nitrate, nitrite, and ammonium contents of the seed-zone. Following harvest, soil samples were taken to 6 meters to determine the concentration and distribution of nitrate and total salts in the profile. Grain yields were similar for plots receiving 22, 67, and 134 T/ha of manure annually. The check treatment yielded less because of nitrogen deficiency and the plots receiving 268 and 538 T/ha yielded substantially less because of high concentrations of salts, ammonium, and nitrite in the soil at seeding time. The detrimental effects of these compounds decreased with time, rainfall, and continued irrigation. The productivity of plots receiving 568 T/ha manure was fully recovered within two years after the applications were stopped. Soil on plots receiving 67 T/ha or more manure annually contained excess nitrate. Some of this nitrate moved as deep as six meters with the irrigation water. However, most of the nitrate accumulated in the top two meters of soil. Manure applied at 22 T/ha was adequate to produce near maximum yields of grain sorghum without causing appreciable accumulations of nitrate or salt in the soil. Where large amounts of manure were applied, concentrations of salts and ammonium decreased within two years to levels that were no longer detrimental to the production or irrigated grain sorghum. (Mathers-USDA)

### 2661 - A1, B2, E2 200

### DIRECT LAND DISPOSAL OF FEEDLOT RUNOFF,

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N. P. Swanson, C. L. Linderman, and L. N. Mielke
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 255-257.

Descriptors: Agricultural runoff, Nutrients, Irrigation, Design.
Identifiers: Land disposal, Field sink, Serpentine waterway.

Land disposal of collected feedlot runoff permits utilization of nutrients and of the water as irrigation. Runoff supplies, however, are not dependable, and facilities and equipment for storage and irrigation distribution require a minimum investment and periodic management irrespective of the size of the feedlot enterprise. Distant overland flow of feedlot runoff, under natural topographic conditions, prior to ultimate discharge into a stream has been judged not to be an environmental hazard in many states. Many feeders would prefer to assume some soil and crop management problems for direct disposal of runoff in lieu of storage and later distribution. This alternative is possible with the use of a field sink on a reasonably level disposal area or a serpentine waterway on a sloping site. Both are described in detail. Direct application on the land can save both investment and time for the many feeders with smaller facilities, and provide adequate protection for the environment. (Swanson-USDA; Merryman, ed.)

### 2662 - A1, B1 E2 200

### LAND DISPOSAL OF BEEF WASTES: CLIMATE, RATES, SALINITY, AND SOIL

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 258-260.

Descriptors: Cattle, Crop response, Nutrients, Salinity, Performance, Agricultural runoff, Leaching, Soils.
Identifiers: Land disposal, Northern Great Plains, Management guidelines.

Disposal of wastes in cold regions with insufficient rainfall for leaching presents some unique problems in waste management. The purpose of this study was to develop management guidelines for the disposal of beef wastes on the land in the Northern Great Plains. The region is characterized by soils with a generally high clay content and a high natural salinity. With generally insufficient leaching water available from natural rainfall, the nutrients and salts added in the wastes accumulate and affect crop growth. The objectives were (1) to evaluate the influence of salt level in the ration upon the wastes produced, (2) to determine the maximum waste application rate for land subsequently cropped and (3) to determine the accumulation and redistribution of waste components applied to the soil. Much of the salt added in the ration is excreted and appears in the manure. The dispersing characteristic of sodium affects waste properties and may be detrimental to soils which already have considerable quantities of sodium present in the profile. Beef wastes were applied to field plots at rates approximating 0, 20, 40, 60, and 80 tons of dry matter per acre. Applications were completed in May, 1974, and corn was planted for silage shortly after field application. The 80 ton per acre rate generally caused poor corn growth. However, for similar application rates, the wastes produced by animals receiving a higher added salt level gave an added detrimental effect on corn growth. Results will be reported for waste characteristics, first year crop yields and animal performance. Results are preliminary for soil effects, runoff and leaching. (Horton-South Dakota State University)

### 2663 - A1, B1, E2 200

### DISPOSAL OF BEEF FEEDLOT WASTES ONTO LAND,

Department of Agricultural Engineering, Kansas State University, Manhattan
H. L. Manges, R. V. Lipper, L. S. Murphy, and W. L. Powers
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 261-263.

Descriptors: Feedlots, Cattle, Kansas, Crop response, Salts, Nitrogen, Equations, Agricultural runoff.
Identifiers: Land disposal, Application rates, Soil cores.

The objectives of the reported research were to determine the optimum feedlot waste application rates onto land with a minimum of pollution to land and the ground water. The research was conducted in cooperation with the Pratt Feedlot, Inc., a 35,000 head commercial feedlot in Southcentral Kansas. Feedlot runoff and feedlot manure were spread onto different land areas at varying application rates for five years. Corn was grown on the waste disposal area. The corn was furrow irrigated from a well as needed for high corn yields. Feedlot runoff application rates were determined from inflow-outflow measurements in the irrigated furrows. Feedlot manure application rates were determined from the weight of manure caught on strips of plastic during spreading. Corn forage yields were measured by weighing forage mechanically harvested from test rows. Soil cores were taken annually and analyzed to determine changes in chemical composition. Highest corn forage yields were obtained at waste application rates in excess of those necessary to supply the recommended nitrogen fertilization rates. However, there was a buildup of salts and nitrogen in the soil. At waste application rates necessary to supply the recommended nitrogen fertilization, corn forage yields were near maximum and salt and nitrogen buildup in the soil were not significant. Corn forage yield prediction equations have been developed from yield data from the waste disposal studies. These equations will be used in determining the most economical waste application rate, both feedlot runoff and manure. (Manges-Kansas State University)

### 2664 - A1, A9, E2 200

### LONG-TERM BROILER LITTER FERTILIZATION OF TALL FESCUE PASTURES AND HEALTH AND PERFORMANCE OF BEEF COWS,

USDA, ARS, Watkinsville, Georgia
J. A. Stuedemann, S. R. Wilkinson, D. J. Williams, H. Ciordia, J. V. Ernst, W. A. Jackson, and J. B. Jones, Jr.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 264-268.

Descriptors: Litters, Fertilizers, Crop response, Health, Performance, Cattle, Fescues.
Identifiers: Grass tetany, Land disposal, Application rates.

Abundance of poultry litter in some areas of the Southeast has resulted in heavy rates of pasture fertilization with poultry litter. Heavy fertilization of tall fescue pastures may be accompanied by an increased incidence of grass tetany and hard fat deposits. An experiment was performed to determine the long-term effects of heavy broiler litter fertilization of Kentucky-31 tall fescue pastures on beef cow health and performance. Three fescue pasture systems receiving three different application rates were utilized. Mean cow weight patterns and the quantities of available forage were directly related to the level of N fertilization. However, there were little differences in adjusted 205-day weaning weights. Conception rates were generally acceptable on all pastures. The occurrence of fat necrosis was related to the level of N fertilization. No appreciable differences in strongyle eggs and coccidia oocysts were observed among cows grazing pastures at the three levels of fertilization.

Broiler litter fertilization resulted in elevated nitrate in soil and herbage, increased arsenic content of cow hair, a trend toward lower grass and blood serum Se levels, and greatly increased size and numbers of earthworms. Intermittent analyses of pond water derived from runoff from the broiler littered pasture indicated a maximum $NO_3$-N content of 5.0 ppm. Soil analyses indicated a maximum $NO_3$-N contents in excess of 10 ppm beneath the fescue root zone. Broiler litter fertilization of fescue pastures appears acceptable from animal health and performance, and environmental quality points of view if no more than 9 metric tons/ha/year are applied. However, at this rate grass tetany prevention techniques will be required as well as good pasture management to utilize the herbage produced. (Stuedemann-USDA; Merryman, ed.)

### 2665 - A1, E2 200

## MANURE FROM CAGED HENS EVALUATED ON FESCUE PASTURE,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 269-270.

Descriptors: Poultry, Fescues, Crop response, Agricultural runoff.
Identifiers: Land disposal.

This study was conducted to determine the maximum level of cage hen manure that can be applied to fescue pastures without injuring the plants or creating detrimental effects from runoff. Six replicated field test plots at the UMC poultry farm were used along with test plots on three commercial poultry farms. The manure applied on the UMC plots (6'x12') was weighed and spread manually. Manure was applied by flail spreaders or a honey wagon. Levels of 10, 20, 30 and 40 T/A were applied in February, 1973. A control plot with no added nutrients and a plot receiving commercial fertilizer supplying approximately the amount of nitrogen equivalent to the nitrogen provided with the use of 10T manure/A was included. Small sheets of plastic and shallow containers were used to measure the quantity of manure applied to each field plot. Strips, 10 feet long, were harvested and dried on May 9, August 1, and October 15, 1973. Strip width was measured and the area mowed was used to calculate the harvest yield. Fescue yields increased as the level of manure applied increased from 0-20T/A on the three farm locations. Levels above 20T/A produced a small additional response when the flail spreader was used; however, the yield was reduced slightly with honey wagon use. The carry-over effect on forage yield during the second year appeared to be minimal. Fescue yields on 6-20-74 at the UMC poultry farm were 2.94, 3.19 and 3.24 (T/A) for 0, 10 and 40T/A respectively. Assays of soil samples demonstrated an increase in P, K, and Ca. Analytical values of fescue harvested May 9, 1973 showed increases in plant tissue levels of N, P, K, Na, Ca, Mg, Cu, Fe, Zn, Mn, Al, B, and Mo when the 40 T/A was compared with the control. These data suggest that cage hen manure should be spread thinly. The maximum level should not exceed 20 T/A. Surface loss due to runoff was minimal. (Vandepopuliere-Missouri University; Merryman, ed.)

### 2666 - A1, D4, E2 200

## THE EFFICIENCY OF USING SLUDGE FROM PIG GROWING COMPLEXES AS ORGANIC FERTILIZER,

Research Investigation Department, Land Reclamation, Research Institute, Spl. Independentei 294, Bucharest V11-17, Romania
Vl. Ionescu-Sisesti, I. Jinga, Gh. Roman, and Gh. Pricop
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 271-273.

Descriptors: Sludge, Fertilizers, Crop response, Fermentation, Pathogens.
Identifiers: Swine, Land application, Application rates.

The experimental results obtained from the utilization as organic fertilizer of the sludge resulting from the purification of the used waters in the industrial pig-growing complexes are presented. The studies have been carried out on a slightly levigated chernosem, well supplied in humus and on an alluvial carbonatic soil medium supplied in humus. It has been found that the sludge can be used as an organic fertilizer like the farmyard manure in all the field crops tested (lucerne, sugar beet, fodder beet, corn, soybeans, sunflower, fibre hemp, potato) and that high and profitable yields can be obtained. The suggested rate is 13-20 t/ha with grain corn and 30 t/ha with fodder beet without chemical fertilizer addition. Since the contamination effect with pathogenous agents on the surroundings has not been followed, the utilization of sludge as an organic fertilizer can only be admitted when no pathogenous agents have been signalled or after disinfection during the fermentation process. (Sisesti-Romania)

### 2667 - A1, E2 200

## THE YIELD RESPONSE OF GRASS TO AEROBICALLY STABILIZED SWINE WASTE,

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S. M. Mutlak, A. D. McKelvie, K. Robinson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 274-276.

Descriptors: Crop response, Slurries, Grasses.
Identifiers: Swine, Land disposal, Application rates, Yields, Composition.

Laboratory and field studies were conducted to determine the effect of aerobically stabilized waste on crops and soil. Comparison was made to a field experiment concerning the effect of rates of waste application on grass growth. Aerobically stabilized slurry, adjusted to contain 8 per cent suspended solids, was applied to $1m^2$ plots in an established perennial ryegrass-clover pasture at rates varying from 12-50$m^3$/ha/14 days. In addition the same rates of suspended solids or liquid of the slurry were applied alone to plots and the results obtained compared with two rates of application of the supernatant liquor from an anaerobic lagoon. The yield and composition of grass were determined at monthly intervals during a three-month period. Statistical analysis of the results revealed that although application of aerobically stabilized waste generally produced a significant increase in yield, the effect of the separate and combined fractions was different varying from zero for the suspended solids to 31 per cent increase for liquid alone. Yield increase for the anaerobic supernatant treated plots was 64 per cent. No clear trend was observed for increased rate of application of aerobically stabilized waste but an increase occurred with anaerobic supernatant. It seemed that the liquid and suspended solids alone and the anaerobic supernatant had a harmful effect. Changes in chemical composition of the grass can be illustrated by nitrogen composition and did not necessarily follow the same pattern as for yield. For example solids alone had no effect. Liquid alone increased the yield and the slurry gave higher nitrogen than its separated components. The anaerobic supernatant gave the highest nitrogen content and it would appear that there is a relationship between the state of the nitrogen applied and its uptake by the plant. (Mutlak-Scotland; Merryman, ed.)

### 2668 - A1, B1, E2 200

## A PRACTICAL MANAGEMENT SYSTEM FOR POLLUTION-FREE LAND SPREADING OF ANIMAL WASTES,

Department of Agricultural Engineering, Newcastle University, England
K. A. Pollock and J. R. O'Callaghan
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 277-281.

Descriptors: Slurries, Nutrients, Legal aspects.
Identifiers: Land spreading, Great Britain, Guidelines.

Trials were conducted to examine the practicability of principles of slurry management published in previous reports of work at Newcastle. They were intended to assess the accuracy of the principles, and their ease of application by farmers and advisors. Hydraulic loading capacity of the soil was estimated from the cumulative soil moisture deficit, which may be reduced by slurry application without causing water pollution. Chemical loading capacity was determined by the crop fertilizer requirements in a season, which may be supplied in the slurry without leaching or accumulation. Under British conditions, the two capacities are of a similar order for some crops to which slurry is applied so that the two criteria may interact under the unique conditions of the farm under consideration. A two-year field trial on two widely separated commercial farms was carried out, with a third site being established later on the University Experimental Farm. In each case, long term planning decisions were possible based on an examination of historical weather data and cropping policies. Day to day management was assisted by calculation of soil moisture deficit using actual rainfall values. Results generally confirmed the spreading principles, there being minimal and short-lived water pollution, and good recovery of most nutrients. Some crop damage was experienced, and under high application rates, near-toxic levels of $NO_3$-N and K were found. Further detailed work is needed on recovery of slurry nutrients by different crops. Preliminary conclusions are that, if the information required was made available to advisors and farmers in an appropriate form, long and short term decisions concerning slurry utilization could be facilitated. (Pollock-England; Merryman, ed.)

### 2669 - A1, B1, E2 200

## NUTRIENT LOSSES FROM LIVESTOCK WASTE DURING STORAGE, TREATMENT, AND HANDLING,

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D. H. Vanderholm
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 282-285.

Identifiers: Nutrient losses, Literature review, Land disposal.

This paper is a review of literature containing data on nutrient losses. This literature review was initiated as a basis for an extension publication on planning land disposal systems and for a section on waste utilization to be included in the Midwest Plan Service Livestock Waste Handbook currently under preparation. In many situations, especially in planning operations, estimates of the quantity and nutrient content of excreted wastes are readily available, but characteristics of the wastes after storage, treatment, and handling are difficult to obtain. Estimates of the nutrient content of the wastes at this stage can be made if losses can be predicted. This literature review contains information on the magnitude of the losses to be expected as well as on the loss mechanisms involved. Examples of the types of losses discussed are ammonia volatilization from feedlot surfaces, ammonia losses during pit storage and spreading operations, denitrification at or near the soil surface, and phosphate precipitation in anaerobic lagoons. The data is presented in summarized form for reference purposes and examples are presented for estimating total nutrient losses on a system basis. (Vanderholm-University of Illinois; Merryman, ed.)

**2670 - A4, B2 200**

## DAIRY LAGOON SYSTEM AND GROUNDWATER QUALITY,

Agricultural Engineering Department, University of Tennessee, Knoxville
J. I. Sewell, J. A. Mullins, and H. O. Vaigneur
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 286-288.

Descriptors: Lagoons, Dairy industry, Tennessee, Sampling, Seepage, Coliforms, Streptococcus, Chloride, Nitrates.
Identifiers: Groundwater quality.

In June, 1973, a manure lagoon and holding pond were constructed for a new 125-cow dairy at the West Tennessee Experiment Station. Research was instigated for determining lagoon seepage rates and the effects of lagoon operation on shallow groundwater quality. The lagoon was constructed in a terrace formation of fine sandy loam of low permeability to a depth of about 6 feet and sands with high permeability at depths from 6-20 feet. The normal water table depth varies from 8-20 feet and has a moderate gradient toward a bottom land. Seven test wells located near the lagoon and holding pond and extending into the groundwater table were installed in June, 1973. From that date until lagoon startup in April, 1974, background levels of groundwater quality parameters were evaluated monthly. At startup, lagoon seepage was about one foot per week with full lagoon. A water balance is being maintained by daily recording the operation of four flush tanks of known volumes. By August, 1974, lagoon seepage had decreased markedly. To date, water-table levels have shown little change due to system operation. Weekly determinations of fecal coliform, fecal streptococci, chloride, and nitrate nitrogen are made for each well. Nitrate-nitrogen and chloride levels have shown little change. However, fecal coliform and streptococci have, in the wells near the holding pond where the groundwater table is about 8 feet below the ground surface, tended to increase. Analysis of available data suggests that the lagoon system operation may have little effect on chemical levels but may increase bacterial concentrations on the downslope side. A system for recirculating lagoon effluent from the holding pond for flushing alleys is under construction. Quality parameters will be determined for the recirculated flush water. (Sewell, et. al.-University of Tennessee; Merryman, ed.)

**2671 - A4, B2 200**

## SEEPAGE BENEATH FEEDYARD RUNOFF CATCHMENTS,

USDA Southwestern Great Plains Research Center, Bushland, Texas
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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 289-290.

Descriptors: Feedlots, Agricultural runoff, Groundwater pollution, Texas, Seepage, Nitrates, Nitrites, Chloride, Soil water.
Identifiers: Catchments, Playas, Soil sealing treatments, Clay liner, *Incorporated bentonite*.

Recent laws require collection and storage of all feedyard runoff for control of surface water pollution; however, seepage from these catchments offer a potential for ground water pollution. Research studies were begun in 1969 at Bushland, Texas, to evaluate the seepage and sealing effects of impounded feedyard runoff. This paper presents results from two types of runoff catchments, one naturally occurring and one man-made. Some feedlots in the area are located near shallow, saucer-type natural lakes called "playas," while holding ponds have been constructed near others to impound the runoff. Soil chemical data have been obtained for samples taken to a depth of 12 feet beneath a playa which has caught feedyard runoff since 1967. These data have been compared to those from an adjacent non-feedyard playa. Nitrate, nitrite, chloride, and soil water were similar in both playas in 1969 and 1974; changes in the feedyard playa were slight from 1969 to 1974. Three soil sealing treatments were compared in three newly constructed holding ponds. The treatments were a clay liner, incorporated bentonite, and check. After the initial impoundment of runoff, water loss rates were similar for all basins. After 45 days from initial filling, the water loss rate approximated the evaporation rate. These studies show that seepage rates beneath feedyard runoff catchments are low and seepage from runoff catchments presents little danger of ground water contamination. (Clark-USDA Southwestern Great Plains Research Center)

**2672 - A3, E2 200**

## NUTRIENT LOSSES FROM MANURE UNDER SIMULATED WINTER CONDITIONS,

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T. S. Steenhuis, G. D. Bubenzer, and J. S. Converse
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 291-295.

Descriptors: Winter, Agricultural runoff, Temperature, Precipitation, Nitrogen.
Identifiers: Land spreading, Nutrient losses.

Pollution caused by winter spreading of manure has received wide publicity. Research information necessary to quantify the effects of climatic factors on the rate of nutrient losses under winter conditions is needed. This research was undertaken to determine the effects of temperature and precipitation on the rate of nutrient transformation from winter spread manure and the surface transport mechanisms that take place during the runoff cycle. To examine the pollution potential of winter spread manure with and without the effect of underlying soil layer, sample plots were covered with 20 cm of snow. Manure was applied as a urine-straw mixture or faeces at three depths within the snow layer. Plots were subjected to four cyclic temperature variations ranging from -8 degrees C to 12 degrees C in an environmental chamber. Radiation conditions equivalent to a cloudy late January day were simulated. At the end of the snow melt period, plots were subjected to simulated rainfall. Eighty to ninety per cent of the nitrogen was lost in the runoff from the snow with a water equivalent of 3 cm, when the urine-straw mixture was placed at the base or midpoint of the snow. Placement at the top resulted in only 10 to 15 per cent of the originally applied N in the meltwater. Losses in runoff from simulated rain were inversely related to the amount lost in the snow melt. Five to twenty-five per cent of the nitrogen of the faeces was lost in the snow melt process. The higher percentages were obtained for placement at the center and on top of the snow pack and subjected to a daily freezethaw cycle. Nitrogen losses from faeces were approximately 10 to 15 per cent of the initial load when subjected to the simulated rain. (Steenhuis, et. al.-University of Wisconsin; Merryman, ed.)

**2673 - A4, B2, E2 200**

## ANIMAL WASTE CONTRIBUTION TO NITRATE NITROGEN IN SOIL,

The Pennsylvania State University, 218 Tyson Building, University Park, Pa. 16802
L. F. Marriott and H. D. Bartlett
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 296-298.

Descriptors: Liquid wastes, Dairy industry, Crop response, Soil water, Groundwater pollution, Nitrogen, Sampling, Lysimeters, Nitrates.
Identifiers: Soil injection Application rates.

Liquid dairy manure was injected on plots of orchardgrass at rates to supply 700-3500 pounds of nitrogen per acre per year for three successive years, and on orchardgrass, bluegrass and corn at rates to supply 300-600 pounds of nitrogen per acre. The concentration of nitrate nitrogen in soil water was determined on samples from suction lysimeters installed at depths of 1, 2, 3 and 4 feet. Crop yields were recorded and samples analyzed to measure nitrogen uptake. Soil samples to a depth of 4 feet were analyzed for nitrate and Kjeldahl nitrogen. The subsurface injection method provided complete control of malodors at the disposal site. Repeated applications of the high rates of manure resulted in increasing concentration of nitrate nitrogen in soil water at all depths of sampling. After applications were discontinued, there was a gradual reduction in nitrate nitrogen concentration with depth from 1 to 4 feet and with rate. The disappearance of the nitrate nitrogen from depths below the root zone indicates the potential for movement into ground water supplies. Manure rates supplying 300-600 pounds nitrogen per acre on bluegrass and orchardgrass increased the concentration of nitrate nitrogen in soil water at 3-4 feet to approximately two times the limit for potable water as set by the Public Health Service. The nitrate nitrogen level decreased 50 per cent in the next growing season. These results are further evidence that the rate of application of animal waste must be adjusted to the crop requirements for N and to soil conditions to minimize the loss of nitrate nitrogen from the root zone. (Marriott & Bartlett-Pennsylvania State University; Merryman, ed.)

**2674 - A3, E2 200**

## EFFECTIVENESS OF FOREST BUFFER STRIPS IN IMPROVING THE WATER QUALITY OF MANURE POLLUTED RUNOFF,

Department of Agronomy, University of Maryland, College Park
R. C. Doyle, D. C. Wolf, and D. F. Bezdicek
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 299-302.

Descriptors: Agricultural runoff, Coliforms, Streptococcus, Nutrients, Water quality, Water pollution.
Identifiers: Land spreading, Forest buffer zones, Dairy manure.

With today's environmental concerns, it is necessary to carefully evaluate the pollution potential of land spreading of manure. The objectives of this experiment were to determine the movement of fecal coliform, fecal streptococcus, total soluble P, K, Na, $NO_3$-N, $NH_4$-N, and organic-N in runoff water from manured land and establish the effectiveness of forest buffer zones in improving the water quality of manure polluted runoff. Dairy manure was applied at the rate of 90 metric tons per hectare, 80 per cent moisture, on 0.19 hectare of a Chester gravelly silt loam soil (Typic Hapludult; fine loamy, mixed, mesic) having a 4 per cent slope and planted in alfalfa. The experimental site was located in the Piedmont physiographic province of Maryland. Runoff was collected from a 35-40 per cent slope forest by means of dust pan lysimeters at 0.0, 3.8, 7.6, 15.2, and 30.5 meter intervals from the manured area. Runoff samples were taken for four natural rainfall events after an initial August, 1973 manure application. A second 90 metric tons per hectare of manure was spread in November, 1973 and runoff from three subsequent rains was collected. Runoff at 0.0 meters displayed high concentrations of P, K, Na, and total N, but fecal coliform and fecal streptococci densities were not significantly higher than background levels. Runoff from the manured area was most highly contaminated in the first rain after manure application, and the runoff water quality showed a tendency to improve with each additional rain. The degree of pollution in the runoff collected at 0.0 meters increased during the winter. Fecal pollutants in runoff water or soil collected at distances of 3.8 meters or greater could not be substantiated by either the biological or chemical parameters measured. Similarly, no effect on the stream adjacent to the plot area was observed during the experiment. (Doyle, et. al.-University of Maryland)

### 2675 - A4, B2 200

## EFFECT OF ANAEROBIC SWINE LAGOONS ON GROUNDWATER QUALITY IN HIGH WATER TABLE SOILS,

Agricultural Engineering Department, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061
E. R. Collins, Jr., T. G. Ciravolo, D. L. Hallock, D. C. Martens, H. R. Thomas, and E. T. Kornegay
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 303-305.

Descriptors: Lagoons, Anaerobic conditions, Coastal Plains, Sampling, Chemical properties, Biological properties, Nutrients, Coliforms.
Identifiers: Swine, Groundwater quality, High water table soils.

The effect of anaerobic swine lagoons on the quality of groundwater in the Coastal Plains was investigated at the Virginia Swine Evaluation Station (VSES) and at the Tidewater Research and Continuing Education Center (TRACEC). The lagoons are located on soils with high water tables near Suffolk, Virginia. Chemical and biological tests were conducted on groundwater sampled at various depths and distances from the lagoons. Constituents determined were nitrates, ammonia, soluble orthophosphates, chlorides, chemical oxygen demand, manganese, copper, zinc, calcium, potassium, magnesium, sodium, and fecal coliform. Wells were water-jetted to 10-, 15-, and 20-foot depths at 10-, 50-, and 100-foot distances from the lagoons. Groundwater samples were taken monthly since August, 1973. The wells were purged one day before sampling. Samples for chemical analysis were stored under ice and dry ice in the field and transferred to a freezer in the laboratory. Before chemical analysis, the samples were filtered through a 0.45 micron filter. The biological determinations were initiated shortly after sampling. Data from the wells at TRACEC indicated influences other than the lagoon on groundwater quality. For this reason, these wells have been abandoned. A new lagoon has since been constructed at this location. Future work will entail monthly monitoring of the groundwater around the new lagoon at TRACEC, monitoring of groundwater around a lagoon on a private farm, and more intensive monitoring of groundwater at VSES with the establishment of more wells. (Collins, Jr. et. al.-Virginia Polytechnic Institute and State University; Merryman, ed.)

### 2676 - A1, B2, E2 200

## NUTRIENT CHARACTERISTICS OF WASTES FROM DEEP PITS AND ANAEROBIC LAGOONS,

Agricultural Engineering Department, Iowa State University.
*J. C. Lorimor, S. W. Melvin, and B. M. Leu*
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 306-308.

Descriptors: Lagoons, Bacteria, Analysis, Sediments, Water, Coliforms, Pathogens.
Identifiers: Land disposal.

Bacterial populations in lagoon water and subsequent disposal of these waters were studied for one year. The objectives of the study were: To establish relationships between the lagoon sediments and the overlying water of certain groups of bacteria, the isolation of pathogenic organisms from the lagoon sediment and water, the survival of certain indicator bacteria, and the effect of land disposal of lagoon waste water. The fecal coliform populations were found to be 10 times greater in the sediments than in overlying water. Aerobic spore-forming bacillus populations were found to be 10 to 100 times greater in the sediments than the overlying water. Fecal streptococcal populations did not vary appreciably during the winter months; however, a 1 to 3 fold increase in the sediment was noted during the summer months. Fecal streptococcal populations were found to survive longer in lagoon water than the fecal coliform populations. Pathogenic organisms, such as Salmonella and coagulase-positive Staphylococcus were more frequently isolated from the sediments than from the overlying waters, indicating that sediments should not be disturbed when disposing of lagoon water. A steady increase in fecal coliform and fecal streptococci populations occurred on the land designated for disposal. The fecal streptococci were found to survive longer in the soil than the fecal coliforms. The results indicate that fecal bacteria are able to survive competition from soil organisms for extended periods of time. (Lorimor, et. al.-Iowa State University; Merryman, ed.)

### 2677 - B2, C1, D3, E3 200

## NITROGEN REMOVAL AND RECOVERY FROM POULTRY WASTEWATER BY ION EXCHANGE,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 309-313.

Descriptors: Poultry, Waste water treatment, Ion exchange, Recycling, Effluents, Aerobic treatment, Equations.
Identifiers: Nitrogen recovery.

An ion exchange process to remove and recover nitrogen from poultry waste-water was investigated. Wastewaters were characterized to determine the feasibility of ion exchange treatment in a close-loop aerobic treatment system and exchange isotherms were generated in laboratory studies. A strong acid cationic H-form macroreticular resin was chosen to investigate removal of $Nh_4^+$. $HNO_3$ was chosen as a regenerant to yield a mixed nitrate salt solution by-product of $NH_4^+$, $K^+$, $Ca^{++}$, and $Mg^{++}$ in excess acid. Flow direction, wastewater concentrations, and acid strengths were varied to determine optimum operating conditions. Ion exchange columns operated in an up-flow fluid-bed mode resulted in essentially complete resin utilization. No $NH_4^+$ leakage was detected until breakthrough at near saturation values. Mass transfer and equilibrium constants for wastewater feed were independent of $NH_4^+$ concentrations over a range of 400-2200 mg/1. Similar constants were *determined for regeneration and were found to vary* over a $HNO_3$ concentration range of 0.5-4N. Design equations and the laboratory determined mass transfer; equilibrium data were used to size a full-scale system. An equation to predict the excess quantities of $HNO_3$ required for regeneration was derived and tested against the data. The buffering capacity of wastewater was found to sufficient for complete recycle of the treated (low pH) column effluent. (Mulkey-EPA)

### 2678 - B1, C5, D3, D4, E1 200

## OXIDATION-NITRIFICATION AND DENITRIFICATION OF VEAL CALF MANURE,

Institute for Soil Fertility, Hasen, The Netherlands
H. G. Van Faassen, H. Van Dijk
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 314-317.

Descriptors: Fermentation, Nitrification, Nitrites, Nitrates, Economics, Cattle.
Identifiers: Phosphate removal.

Experiments were done utilizing laboratory fermentors (2 to 20 liters). Information about COD and NOD of manure was presented. Until now, for complete denitrification a minimum C/N ratio of 6 was supposed to be necessary. In these experiments, a C/N of 1.7 proved to be sufficient. Nitrification to nitrite is more economical than nitrification to nitrate. In the experiment, removal of more than 95 per cent of the nitrogen was possible. Adding certain amounts of $Ca(OH)_2$ did not harm the biological process and resulted in a phosphate removal of about 90 per cent. (Van Faassen-Netherlands)

### 2679 - A1, B2, E2 200

## BACTERIAL ANALYSIS AND LAND DISPOSAL OF FARM WASTE LAGOON WATERS,

Department of Bacteriology, North Dakota State University, Fargo, North Dakota
D. R. Smallbeck, M. C. Bromel
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 318-321.

Descriptors: Lagoons, Bacteria, Analysis, Sediments, Land disposal, Water, Coliforms, Pathogens.

Bacterial populations in lagoon water and subsequent disposal of these waters were studied for one year. The objectives of the study were: To establish relationships between the lagoon sediments and the overlying water of certain groups of bacteria, the isolation of pathogenic organisms from the lagoon sediment and water, the survival of certain indicator bacteria, and the effect of land disposal of lagoon waste water. The fecal coliform populations were found to be 10 times greater in the sediments than in overlying water. Aerobic spore-forming bacillus populations were found to be 10 to 100 times greater in the sediments than the overlying water. Fecal streptococcal populations did not vary appreciably during the winter months; however, a 1 to 3 fold increase in the sediment was noted during the summer months. Fecal streptococcal populations were found to survive longer in lagoon water than the fecal coliform populations. *Pathogenic organisms, such as Salmonella and* coagulase-positive Staphylococcus were more frequently isolated from the sediments than from the overlying waters, indicating that sediments should not be disturbed when disposing of lagoon water. A steady increase in fecal coliform and fecal streptococci populations occurred on the land designated for disposal. The fecal streptococci were found to survive longer in the soil than the fecal coliforms. The results indicate that fecal bacteria are able to survive competition from soil organisms for extended periods of time. (Smallbeck-North Dakota State University)

**2680 - A9, B1, C2, C4 200**

## A MYCOLOGICAL INVESTIGATION OF BEEF FEEDLOT MANURE IN A SEMIARID TEMPERATE CLIMATE,

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R. G. Bell
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 322-324.

Descriptors: Fungi, Decomposing organic matter.
Identifiers: Unpaved feedlots, Dilution plate technique.

An investigation was undertaken to determine the magnitude, composition, origin, and ecological significance of the fungi present in manure on the surface of an unpaved beef feedlot. Enumeration and isolation were accomplished using the dilution plate technique at incubation temperatures of 25, 37, and 55 degrees C on Rose Bengal-streptomycin-supplemented Sabourard's, Czapek-Dox, and Manure Extract agars. The only thermophilic fungi isolated were Thermomyces lanuginosus, a Talaromyces (Penicillium) sp., a Mucor sp., and Chaetomium thermophile var. coprophile. With the exception of the Chaetomium, all were also present in the feed. The number of thermophiles remained almost constant throughout the investigation, which probably indicates their presence as spores. The dominant fungi isolated at 25 degrees C were members of the Mucorales, typical of early stages of organic matter decomposition. A direct relationship between moisture content and fungal population was observed; the extremes were 500 and 21,000 propagules-g dry manure at 10.5 and 55.2 per cent moisture content, respectively. This numerical change was accompanied by redistribution of population from a 100:1 predominance of Mucorales over Moniliales at high moisture content to a 1:1 ratio at low moisture content. At 10.5 per cent moisture content, the Moniliales (250/g dry manure) all Aspergillus sp., were shown by differential medium of Bothast and Fennell to be potentially aflatoxic. Similar strains were isolated from the feed. Laboratory studies indicated that feedlot manure under conditions favorable to decomposition, 65 per cent water content, supported 350,000, 250,000 and 3000 propagules/g dry manure at 25, 37, and 55 degrees C, respectively. This observation, coupled with the characteristic low moisture content found in surface manure samples, supports the hypothesis that little decomposition is effected, by the mainly feed-originating fungi, on the feedlot surface. The potential hazard of aflatoxin production is, therefore, minimal on a dry feedlot but should not be overlooked when considering ultimate manure disposal. (Bell-Canada; Merryman, ed.)

**2681 - D3, E3 200**

## MODIFICATION AND ENZYMATIC HYDROLYSIS OF FEEDLOT WASTE,

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C. K. Elmund, D. W. Grant, and S. M. Morrison
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 325-327.

Descriptors: Hydrolysis, Feedlots, Nutrition.
Identifiers: Farm wastes, Refeeding, Fenton's Reagent, C. utilis.

Various environmental and economic factors have emphasized the need to develop processes for increasing the biodegradability of cattle feedlot manure and for upgrading its nutritional value for refeeding. A rate-limiting factor during microbial decomposition of manure is the depolymerization of the cellulosic fraction, a major constituent of feedlot waste. One phase of our research project is the evaluation of Fenton's Reagent (FR) to partially depolymerize the cellulosic fraction to facilitate its enzymatic hydrolysis to reducing sugars. The products may subsequently serve as substrates for the growth of microorganisms for feed supplements or other economically valuable products. The objectives of our study include optimizing conditions for FR-catalyzed depolymerization and enzymatic hydrolysis of the cellulosic fraction, producing feed yeast on reacted manure substrate, and evaluating the nutritional value of the resulting product. A description of research procedures is given. Preliminary results suggest that manures reacted with Fenton's Reagent and cellulase are suitable substrates for the growth of C. utilis. Manures processed in this manner may serve as nutritionally valuable supplements in proposed refeeding systems. (Elmund, et. al-Colorado State University; Merryman, ed.)

**2682 - A1, C3, E2 200**

## INFLUENCE OF ANTIBIOTICS AND GROWTH PROMOTING FEED ADDITIVES ON THE MANURING EFFECT OF ANIMAL EXCREMENTS IN POT EXPERIMENTS WITH OATS,

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C. Tietjen
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 328-330.

Descriptors: Antibiotics, Additives, Feeds, Performance, Crop response, Biodegradation.
Identifiers: Feed conversion efficiency.

Supplementation of animal feed by antibiotics and other additives is aimed at increase of weight gains, increase of feed conversion efficiency and maintenance or restoration of animal health. High stability is demanded of antibiotics; no resorption in the alimentary canal shall occur. Consequently, they are excreted and need consideration in animal waste disposal. In experiments of G. K. Elmund et. al. (1971), 75 per cent of the dietary chlortetracycline was excreted; antibiotic supplementation apparently altered the digestive processes in the animal, resulting in less biodegradable feces, thus increasing the environmental pollution potential. Application of antibiotics in plant nutrition and plant protection influences crop growth in manifold ways. In pot experiments with oats, we applied aureomycin, bacitracin, and streptomycin to the soil; they did not affect dry matter production and nitrogen content. But applied together with two varieties of chicken manure, dry matter production decreased; content was increased; 71 per cent in grain, 96 per cent in straw. In similar pot experiments, pooled fresh excrements from broilers and from pigs were used which were collected during investigations on the nutritive effect of supplementation with carbadox, oleandomycin, oxytetracyclin, flavomycin, virginiamycin, zincbacitracin, peson, and quindoxin. As interaction with increasing rates of nitrogen fertilizer, we observed hindering as well as furthering of crop growth. Remarkable increase of dry matter production was caused by carbadox; higher nitrogen contents were related to flavomycin, oxytetracyclin and oleandomycin. Dietary supplementation by antibiotics and other kinds of additives may modify the biodegradation of the excrements as well as their manuring effect in crop production. (Tietjen-Institut fur Pflanzenbau und *Saatgutforschung der Forschungsanstalt* fur Landwirtschaft)

**2683 - A1, B2, D4, E3 200**

## OPTIMUM DILUTION OF SWINE WASTES FOR GROWTH OF LEMNA MINOR L. AND EUGLENA SP,

Environmental Biology Branch in cooperation with Agricultural Resource Development Branch, Tennessee Valley Authority, Muscle Shoals, Alabama 35660.
R. A. Stanley and C. E. Madewell
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 331-333.

Descriptors: Fish diets, Algae, Oxygen.
Identifiers: Swine, Anaerobic lagoon, Fish production, Tennessee Valley Authority, Pond enrichment, Loading rates, Phytoplankton.

One means of animal waste disposal is the use of wastes to enrich enclosed ponds for increased production of fish or shellfish. This approach is being used at Woods Hole Oceanographic Institute for marine shellfish, and should work equally well for freshwater systems. Three possible systems that TVA intends to test are (1) Lemna minor L. (or some other duckweed) consumed by white amur, (2) algae consumed by a freshwater shellfish, and (3) algae consumed by phytoplanktivorous fish such as silver amur. The proper dilution rate for L. minor L. and phyto-plankton was determined in glazed ceramic containers under greenhouse conditions. Containers held 8 l of fluid and had 350 cm$^2$ surface area. Fluid for waste enrichment was obtained from a local primary treatment lagoon (anaerobic) that receives wastes from a swine feeding operation. Additions were made three times per week. L. minor L. from a local pond was added at 10 g fresh weight per container. Inocula for phytoplankton were obtained from a dilution series that had been spiked with seven water samples containing natural phytoplankton flora. About 2 g fresh weight of mixed phytoplankters was used to innoculate the experimental dilution series. Plants were harvested once a week, dried overnight at 70 degrees C, and weighed. Oxygen was determined with a YSI model 53 oxygen monitor. Loading rate for optimum growth of L. minor L. was 19 ml/l/wk. Dissolved oxygen during the day at this loading rate was normal (saturated), while at night oxygen was about one-half saturated (4.[illegible] PPM). Maximum growth of Euglena-sp. was obtained at the highest loading rate tested 150 ml/l/wk. Day and night oxygen concentrations at this loading rate were below 2ppm, a level reported to be tolerated by Asiatic clams and silver amur but considered dangerously low. The highest loading rate used at which dissolved oxygen remained above 2ppm, both day and night, was 38 ml/l/wk. (Stanley and Madewell-TVA; Merryman, ed.)

**2684 - A9, B2 200**

## SWINE WASTE LAGOONS AS POTENTIAL DISEASE RESERVOIRS,

Department of Veterinary Pathology, Iowa State University, Ames, Iowa.
R. D. Glock and K. J. Schwartz
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 334-335.

Descriptors: Lagoons, Diseases, Pathogenic bacteria, Liquid wastes, Recircuiated water, Salmonella.
Identifiers: Swine, Flushing gutter systems, Dysentery.

Swine waste lagoons and pits have been rapidly increasing in numbers due to their practicality. The design, construction, and use of these systems has been quite thoroughly described but the question of whether pathogenic organisms can persist in liquid waste and act as biological hazards has not been *adequately considered. Systems utilizing recirculation* of lagoon effluent in flushing gutter systems would seem to be especially hazardous. Two groups of 3 pigs each were deprived of fresh water but were fed anaerobic lagoon effluent from gutter-flush tanks on a farm with a history of swine dysentery and salmonellosis. Two similar groups were held as controls with free access to clean water. This study revealed that effluent used to flush gutters was capable of initiating S. st. paul infections and clinical swine dysentery. Salmonella st. paul was also isolated from the lagoon effluent. T. hyodysenteriae-like organisms were observed in low numbers but isolation attempts failed. Further surveys of swine waste lagoons and pits resulted in isolation of Salmonella from 4 to 13 anaerobic lagoons and from 1 of 3 sub-floor pits. Serotypes isolated included S. molade, S. st. paul, S. typhimurium, S. manhattan, and S. agona. Pathogenicity of the various serotypes isolated is not known but it seemed significant that, in 2 instances, the same serotypes were isolated both from lagoon effluent and from rectal swabs of swine on the same premises. There was some indication that isolations of Salmonella were more frequently accomplished during the colder seasons. These findings do not suggest that anaerobic lagoons are undesirable but that more study is needed to determine specific disease transmission hazards. The potential of swine wastes as Salmonella reservoirs also needs further clarification. (Glock & Schwartz-Iowa State University; Merryman, ed.)

**2685 - A1, B1, E2 200**

### EXCRETION OF SALTS BY FEEDLOT CATTLE IN RESPONSE TO VARIATIONS IN CONCENTRATIONS OF SODIUM CHLORIDE ADDED TO THEIR RATION,

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L. R. Shuyler, D. A. Clark, J. Barth, and D. D. Smith.
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 336-338.

Descriptors: Salts, Feedlots, Diets, Cattle, Performance, Soil contamination.
Identifiers: Land disposal.

The Robert S. Kerr Environmental Research Laboratory (RSKERL) and the National Environmental Research Center, Las Vegas (NERC-LV), with the concurrence of the Nevada Operations Office of the Atomic Energy Commission (AEC), jointly conducted a study of feedlot cattle maintained on an experimental farm at the Nevada Test Site (NTS) to determine the effect of different salt supplementation regimes on the production of beef and on the total excretion of salt in the animal wastes. The practice of including sodium chloride (NaC1) in the diet of feedlot cattle at levels greater than 0.5 per cent has caused salt accumulations in soils used for animal waste disposal in arid regions of the U.S. In this study, a feedlot diet of ground alfalfa, ground grain sorghum, cottonseed meal, and limestone was supplemented with different NaC1 levels (0.5 per cent, p. 25 per cent, and 0 per cent). Urine and fecal samples were collected from cattle being fed controlled amounts of NaC1 and analyzed for NaC1 and other important parameters. Samples of feed and water were also analyzed for the same parameters. The animals used in this study were sacrificed, and grade and yield of the carcasses were determined. The rate of gain and conversion efficiency were also measured. The study indicated that salt content in feedlot ration was reduced below the 0.5 per cent level without affecting beef production. The NaC1 content in the waste decreased as the NaC1 content of the feed was reduced. These results indicated that land loading rates for animal waste disposal in areas where salt is the limiting factor may be increased by lowering the salt content of the feed. (Shuyler-Robert S. Kerr Environmental Research Center)

**2686 - A9, B1, C3, E3 200**

### PARTICLE-SIZED DISTRIBUTION OF LIVESTOCK WASTES,

Assistant Professor, Department of Soil Science, California University, Riverside
A. C. Chang, and J. M. Rible
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 339-343.

Descriptors: Separation techniques, Feeds, Value.
Identifiers: Refeeding

In recent years, animal wastes from confine feeding operations have often been considered as a source of feed or feed supplements. There were many feed trials to determine the response of animals with mixed results. In general, it is recognized that small amount of manure additive in feed is not harmful to the animal. However, there are also serious drawbacks of such feeds due to certain unfavorable constituents in the waste. It is the belief of the authors that certain portion of the waste could become valuable feed to the livestock animals. The purpose of this study is to physically separate the waste into various fractions according to particle size and determine the feed value of each fraction. For this purpose, various aged and freshly collected animal waste samples were collected from confine feeding beef feedlots, dairies and poultry ranches for the analysis. A vibrating sieve shaker was used to separate the aged dry waste samples. The freshly collected wastes were separated by a wet sieving technique. Crude fiber, protein, fat, nitrogen free extracts, ashes, and moisture contents were determined to calculate the total digestible nutrient. Amino acid and organic acid compositions are also determined to assess their potential as feedstuff. (Chang-California University)

**2687 - B1, C2, C3, E3 200**

### DECOMPOSITION RATES OF BEEF CATTLE WASTES,

Department of Agricultural Engineering, Colorado State University, Fort Collins
M. L. Stone, J. M. Harper, R. W. Hansen
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 344-346.

Descriptors: Organic wastes, Cattle, Recycling, Chemical properties, Physical properties, Odor, Feedlots.
Identifiers: Decomposition rates, pH.

Manure has gained importance as a source of feed, fertilizer, and energy. This study describes the physical and chemical changes that occur in manure from the time it is deposited to the time it is picked up for utilization. The major objective of this study is to evaluate the waste of this resource due to decomposition. A controlled temperature-humidity chamber was used to incubate manure at constant temperature and moisture levels. During incubation the manures were monitored. Chemical properties monitored were total nitrogen, protein nitrogen, $NH_3N$, acid detergent fiber, ash, and pH. Physical properties monitored were odor, bulk density, particle size, viscosity, and squeezability. The effect of manure decomposition was greatest on its viscosity and squeezability. The viscosity of a slurry of manure incubated at 70 per cent moisture content and 120 degrees F doubled in a ten day period. The manure's squeezability decreased 6 per cent in the same period. In contrast, bulk density and particle size remained the same. Change in odor closely corresponded to pH change. The pH decreased the first two days and then increased the rest of the 10 day incubation period. Other chemical properties excluding ammonia showed little change in high moisture (70 per cent) manure incubated at high temperature (120 degrees F). At low temperatures, neither physical or chemical properties changed as would be expected. Data indicate that chemical changes of manure are relatively slow compared to some of the changes in physical properties. This may have a profound impact on manure slurry handling systems and on collection frequency necessary to obtain optimum benefit from manure. (Stone-Colorado State University; Merryman, ed.)

**2688 - A1, B1, C3, E2 200**

### CHEMICAL CHARACTERISTICS OF BEEF FEEDLOT MANURES AS INFLUENCED BY HOUSING TYPE,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 347-350.

Descriptors: Feedlots, Chemical properties, Climates, Michigan, Cattle, Nutrients, Salts.
Identifiers: Housing types.

Climate influences decomposition of manure and transformation of its constituents. Housing types in feedlots modify climatic influence, and thus, could affect decomposition and composition of manures. There are three major feedlot housing types in Michigan: open-lot, dry-lot, and the total-confinement systems. Six feedlots in southern Michigan, with one or more housing type, were chosen to evaluate: (1) chemical composition, with emphasis on N, P, and K, of fed beef cattle manures as affected by various housing types, and (2) $NO_3$ and salt status of farms receiving these manures. These feedlots had various manure scraping frequency and a wide range of animal density and size. Manure and fresh fecal samples were collected four times at bimonthly intervals from spring to fall of 1973. Soil samples to 2 ft. deep from manured and unmanured areas were collected four times during the corn growing season. The organic matter contents of manures indicate its degree of exposure to climate. In lots with more favorable evaporative conditions, organic matter was high, on gravimetric basis. This was true in open-lots, followed by dry-lots. But in total-confinement with slotted floor, organic matter was low. The N contents of manures from open-lots were generally low, with an average of 1.1 per cent (dry-basis). Manures from dry-lot and total-confinement systems had more than twice the N of open-lot manures. This pattern suggests that greater amounts of N were lost from open-lots, possibly largely by $NH_3$ volatilization. In open-lots P tended to be lower in manure than in fresh feces, probably caused by runoff or leaching losses. However, in dry-lot and total-confinement systems, P in fresh feces and manures was about equal. Potassium was generally low in open-lot manures. On the average, fresh feces had lower K than manures. Data for Ca, Mg, Na, Fe, Mn, Zn, and Cu is also discussed. Field data show generally higher levels of $NO_3$ and C1 in soils in manured than control areas. However, no significant salt buildup was detected. (Adriano-Michigan State Univ; Merryman, ed.)

**2689 - A5 200**

### IDENTIFICATION AND MEASUREMENT OF VOLATILE COMPOUNDS WITHIN A SWINE BUILDING AND MEASUREMENT OF AMMONIA EVOLUTION RATES,

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J. R. Miner, M. D. Kelly, and A. W. Anderson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 351-353.

Descriptors: Odor, Confinement pens, Ammonia, Measurement.
Identifiers: Swine, Volatile compounds.

This project was initiated to find a practical way of identifying and monitoring odorous volatiles. Volatile compounds produced in a swine confinement building were trapped by porous polymers and identified by combined gas-liquid chromatography and mass spectrometry. Gas-liquid chromatograph outputs were used as the basis for estimating concentrations. Air from a swine center was drawn through traps containing either Tenax GC or Poropak Z. The traps were first heated to 55 degrees C for one hour to remove water and then reversed and reheated at 150-200 degrees C to remove trapped volatiles. The entrained volatiles were transferred to an open tubular stainless steel trap immersed in dry ice. The small cold traps were then connected to the gas chromatograph and-or mass spectrometer by modified inlet systems. About 25 compounds were identified by this method, including organic acids: acetic, propionic, butyric, and valeric. Their concentrations were determined by using an integrator attached to the chromatograph. They were all found to be in the 10-6 ug-1 range. This technique was then used to measure the evolution rate of ammonia as well as the transport properties of these compounds upon release. Native grasses, soil and surface water were all demonstrated to have significant ammonia absorption properties. Values for dairy barn floors, feedlot surfaces, manured fields and lagoon surfaces are reported. (Miner, et. al.-Oregon State University; Merryman, ed.)

### 2690 - A5 200

### QUANTATIVE MEASUREMENT AND SENSORY EVALUATION OF DAIRY WASTE ODOR,

Battelle's Columbus Laboratories, 505 King Avenue, Columbus, Ohio 43201
C. N. Ifeadi, E. P. Taiganides, and R. K. White
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 354-357.

Descriptors: Odor, Measurement.
Identifiers: Dairy wastes, Volatile compounds, Diethyl sulfide, Dimethyl sulfide.

Instrumentation for the quantitative measurement and sensory evaluation of odor is developed. The system comprises (1) a sample collector, (2) a sample injection system, (3) gas chromatograph (GC), and (4) dilution system consisting of a diffusion cell, series of rotameters, and a sniffing hood. Dairy waste odorous compounds are collected with the sample collector at ambient conditions. The injection system is a specially designed apparatus for transferring the samples from the collector into the GC for identification and quantification. The diffusion cell which was placed in a constant temperature medium is used to diffuse calibrated amounts of odorants into the dilution system. Rotameters are used to dilute the odorants with odor free air so that different concentrations of the odorants may be analyzed by GC and evaluated organoleptically at the sniffing hood. Volatiles from dairy waste stored in a diluted and undiluted state are analyzed. Dimethyl sulfide and diethyl sulfide are quantified. Average concentration for analyses of the diluted manure volatiles are 0.3 ppm for diethyl sulfide, and 65.4 ppm for dimethyl sulfide; while the volatiles from the undiluted are 2.7 ppm for diethyl sulfide and 34.9 ppm for dimethyl sulfide. Sensory evaluation showed that the odor threshold of the diluted dairy waste was lower than the undiluted waste by a factor of ten. (Ifeadi, et. al.-Battelle's Columbus Laboratories, etc.)

### 2691 - A5 200

### EVALUATION OF ODOR INTENSITIES AT LIVESTOCK FEEDING OPERATIONS IN TEXAS,

Agricultural Engineering Department, Texas A&M University, College Station 77843
D. L. Reddell and J. M. Sweeten
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 358-361.

Descriptors: Feedlots, Texas, Cattle.
Identifiers: Odor measurement, Odor intensity standards, Vapor dilution, Liquid dilution, Scentometer, Swine.

An experiment was conducted to correlate results from two odor measurement techniques—vapor dilution and liquid dilution. A scentometer was used to measure odors at both a cattle feedlot and a swine operation. Manure samples from these operations were brought into the laboratory and the odor intensity was measured using a liquid dilution technique. The odor readings determined by each panel member for several months were plotted as probability distribution functions. Using Monte Carlo simulation techniques, a composite probability distribution of odor intensity for the entire panel was predicted and shown to correlate with the field and laboratory measurements. Using probability distributions, a correlation between the field readings obtained with a Scentometer and the laboratory readings using the liquid dilution method was explored. Odors were measured using a Scentometer at three Texas cattle feedlots (400, 12,000 and 30,000 head capacities). Within each feedyard, odors were also monitored along side the runoff retention ponds at one feedlot. Diverse conditions of weather, drainage, and manure management were encountered. Odor intensity frequency distributions were developed for each feeding operation. These revealed that the feedlots would have exceeded odor intensity standards of 7 to 8 $D_t$ (in effect in four states) from 40 to 85 per cent of the time. However, the 127$D_t$ standard for two states would have been exceeded no more than 5 per cent of the time. The authors concluded that the minimum odor level that can reasonably be expected at cattle and swine feeding operations is 7 $D_t$. (Reddell & Sweeten-Texas A&M; Merryman, ed.)

### 2692 - A6, B1 200

### MANURE GASES AND AIR CURRENTS IN LIVESTOCK HOUSING,

Swedish Institute of Agricultural Engineering, S-750 07 Uppsala 7, Sweden
Sven-Uno Skarp
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 362-365.

Descriptors: Livestock, Ventilation, Hydrogen sulfide.
Identifiers: Sweden, Manure gases, Confinement buildings.

In Sweden, liquid handling of livestock wastes from confinement buildings developed during the early 1960's. It gradually became clear that gas formation from the liquid manure could be a problem. Several serious gas poisoning accidents among pigs and cattle drew attention to this fact. Studies were made by the Swedish Institute of Agricultural Engineering into the presence and distribution of manure gases under different conditions. The following conclusions were derived from these studies. The main factors for the distribution of gases were temperatures and air currents. Solid manure did not release gases in quantities injurious to animals or humans. Liquid manure released gases, of which hydrogen sulfide sometimes appeared in toxic concentrations. Static liquid manure released hydrogen sulfide in measurable quantities only if the manure originated from pigs. Liquid manure handled or set in motion by pumping, mixing, spreading or cleaning-out released large amounts of gases, particularly hydrogen sulfide. The normal ventilation design was found to have a great influence on the distribution of manure gases. The largest problems were caused by currents of cold air at low heights due to ineffective mixing and distribution of the incoming fresh air from the air inlets. The design and location of air inlets and the way the air was distributed determined the climate in the livestock building. The design and location of the exhaust fans were of minor importance for the correct control of incoming fresh air. Balanced ventilation system gave the best conditions compared with systems of slight negative and positive pressure. (Skarp-Sweden)

### 2693 - A5, A6, B2 200

### EXHAUST SYSTEMS FOR UNDER-FLOOR LIQUID MANURE PITS,

Department of Agricultural Engineering, Maryland University, College Park
D. S. Ross, R. A. Aldrich, D. E. Younkin, G. W. Sherritt, and J. A. McCurdy
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 366-368.

Descriptors: Odor, Air pollution, Design, Ventilation.
Identifiers: Storage pits, Slotted floors, Exhaust systems.

Liquid manure storage pits in enclosed buildings with partially slotted floors can produce unpleasant and injurious odors for people and animals within the buildings. A method for removing such odors from a manure pit is to exhaust air from beneath the slotted floor directly to the outside of the building. Continuous ventilation should prevent gases from moving outside the pit area. Laboratory and field studies were made to find satisfactory exhaust systems which would provide effective odor control and acceptable air distribution and temperature. Laboratory studies of 100 ft. each of 6- and 8-inch diameter perforated plastic pipe were made. With a design flow of 4 cfm per ft. for the 6-and 8-inch diameter pipes with holes spaced 1 ft. apart. The standard deviations were 0.52 and 0.50 cfm, respectively, with the test values generally decreasing with distance from the exhaust fan. In the field installation, the odor control was satisfactory. Since it is not possible to install a perforated pipe system in all barns, an alternative was developed. A tapered duct was designed according to ASHRAE Guide Procedures which would permit all ventilation air to pass through the pit. Such as system was installed at the PSU Swine Research Center and monitored. Air distribution and temperature control were acceptable thoughout the winter period; however, odor control was not satisfactory because airflow through the pits during cold periods was not sufficient to prevent odors from entering the occupied zone. Providing a higher airflow by lowering the minimum temperature to 45 degrees F improved the odor control. (Ross, et. al.-Maryland and Pennsylvania; Merryman, ed.)

### 2694 - A5, B1, D3 200

### MALODOR REDUCTION IN BEEF CATTLE FEEDLOTS,

Professor and Instructor, respectively, Department of Agricultural Engineering, Texas Tech University, Lubbock
W. L. Ulich and J. P. Ford
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 369-371.

Descriptors: Feedlots, Cattle.
Identifiers: Odor control, Chemical treatment, Manure pack.

An investigation was conducted in order to: (1) thoroughly review current odor control technology, (2) investigate various control treatments, and (3) provide practical odor control guidelines for confined beef cattle feedlots. Seven control materials were selected for detailed investigation. Preliminary laboratory tests consisted of one hundred grams of solid or one hundred milliliters of liquid samples to which various amounts of control materials were added. Sulfureous compounds, amines, and possibly ammonia were found to be common important components of cattle feedlot odors. Organoleptic tests or digestive deodorants were not found to prevent the release of any of the malodorous gases for which the tests were conducted. Digestive deodorants did effect time of release. Chemical treatments using hydrogen peroxide, paraformaldehyde, potassium nitrate, and various commercial formulas were found to provide some control at relatively high concentrations. These chemicals, however, were later judged to be more expensive at the required concentrations than other chemical control applications. Potassium permanganate and orthodichlorobenzine were estimated to significantly reduce malodors when sprayed in a 1 per cent water solution at rates of 20 pounds and 6 gallons per acre of feedlot respectively. In any odor control system good housekeeping cannot be over-stressed. Moisture control of the manure pack is much more important than the frequency of pen cleaning. A shallow porous, aerobic blanket of loose manure should be maintained over a 25-40 per cent moisture manure pack, where possible, for odor and dust control. Current recommendations consist of a critically controlled manure pack and a chemical spray plan as an emergency standby. (Ulich and Ford-Texas Tech; Merryman, ed.)

### 2695 - A5, A8, B1, C5, D4 200

### THE USE OF DRIED BACTERIA CULTURES AND ENZYMES TO CONTROL ODOR AND LIQUEFY ORGANIC WASTE FOUND IN HOG, DAIRY, AND POULTRY PRODUCING UNITS AS WELL AS LAGOONS,

Big Dutchman, Division of U.S. Industries, Inc. 200 Franklin, Zeeland, Michigan
J. F. Bergdoll
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 372-373.

Descriptors: Liquification, Organic wastes, Lagoons, Enzymes, Additives, Dairy industry, Poultry.
Identifiers: Odor control, Dried bacteria cultures, Swine, Fly control.

Our object was to find cultured bacteria and enzymes that safely control ammonia and odors, reduce mass, and/or liquify organic waste. Different strains and levels of bacteria and enzymes were used on waste beneath cages, on feeding floors, in hog pits, and lagoons. Several oxidizing and neutralizing agents were added. Materials were applied as a spray or as a dust on liquid pits and lagoons. The treatments result in up to 50 per cent reduction of the BOD count in all cases; solids were liquified; and odors were reduced. In addition, drain-lines were kept clear of all organic waste build-up. Different products were used for general odor control and where manure or waste was being handled as a liquid. Proper utilization of products containing a minimum of 1½ billion anaerobic and 4 billion aerobic bacteria per gram plus enzymes and other additives; most effectively controlled odors, aided in fly control, reduced volume, and liquified organic waste. (Bergdoll-Michigan; Merryman, ed.)

### 2696 - A5, B2, D3, D4 200

### ODOR CONTROL OF LIQUID DAIRY AND SWINE MANURE USING CHEMICAL AND BIOLOGICAL TREATMENTS,

The Pennsylvania State University, Department of Agricultural Engineering, University Park
C. A. Cole, H. D. Bartlett, D. H. Buckner, and D. E. Younkin
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 374-377.

Descriptors: Liquid wastes, Dairy industry, Chemical treatment, Biological treatment.
Identifiers: Odor control, Swine.

Dairy and swine wastes stored in liquid manure pits produce foul smells due to such components as sulfide, mercaptans, indole, skatole and ammonia. Work has nearly been completed on evaluation of chemical and biological treatment methods to eliminate these odors at the time of agitating and spreading (short-term control) or prevent their formation during storage (long-term control). Procedures were developed to measure odor levels subjectively, using an odor panel, and to measure $H_2S$ and $NH_3$ levels, using specific ion electrodes in order to evaluate the treatment methods. The chemical oxidants NaOC1, $H_20_2$, $C10_2$ and $KMnO_4$ at doses of 500 mg/l were shown to be effective for odor control of swine waste on bench scale experiments. All these oxidizing compounds reduced the $H_2S$ from levels near 100 mg/l to near or below 10 mg/l at the 500 mg/l dosage rate for waste of 5-7 per cent total solids. The most economical materials, $H_2O_2$ and $KMnO_4$, were found to cost $2.58 and $3.12 per thousand gallons of waste treated, respectively. Full scale tests on swine waste verified that they reduced odor substantially. Commercial proprietary materials utilizing enzymes, specific bacteria and disinfectants were compared with lime treatment for high pH adjustment and $NH_4NO_3$ and $NaNO_3$ treatment for oxygen supply to prevent odor formation in swine pit contents. None of the materials studied during the long-term trials, carried out in 208 liter drums over an eight-week period, significantly reduced odor of the swine manure. In addition, no noticeable reduction in $NH_3$ or $H_2S$ levels was found. Trials are currently being conducted with the commercial odor control materials and the best short-term chemicals on dairy pit contents. (Cole, et. al.-Pennsylvania State University; Merryman, ed.)

### 2697 - A5, B1 200

### MANAGEMENT OF ODORS ASSOCIATED WITH LIVESTOCK PRODUCTION,

Department of Agricultural Engineering, Oregon State University, Corvallis
J. R. Miner
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 378-380.

Descriptors: Livestock, Poultry, Economics, Design.
Identifiers: Odor control.

This paper reviews and organizes existing research knowledge in livestock waste odors technology and attempts to draw from it a set of usable techniques for the concerned livestock producer or consulting engineer. Although difficult to quantify, certain practices and design choices have advantages in odor control. Among the techniques usable to minimize the potential of odor complaints are proper site selection, site modification, inhibition or modification of manure decomposition, odor making, odor absorption, and public relations. All of these techniques can be incorporated into an overall odor control program with a reasonable probability of success. The economics of odor control, unlike the economics of other livestock production costs are highly site dependent. The value of a specific site for animal feeding must be adjusted according to the anticipated cost of odor management. The chemistry of animal waste odor control suggests a use of several physical and chemical modifications to existing feedlots and confinement facilities. A combination of techniques has the potential of making odors less intense and less frequent. An analysis of livestock odor problems must include both intensity and frequency descriptions if rational decisions are to be made. (Miner-Oregon State University; Merryman, ed.)

### 2698 - A5, B2, D3 200

### CHEMICAL TREATMENT OF LIQUID DAIRY MANURE TO REDUCE MALODORS,

Agricultural Engineering Department, Delaware University, Newark
W. F. Ritter, N. E. Collins, and R. P. Eastburn
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 381-384.

Descriptors: Chemical treatment, Liquid wast
Dairy industry
Identifiers: Odor control, Hydrogen peroxid
Alamask 518, Alamask 151A.

The research to be reported in the paper evaluates t effectiveness of chemical agents to control odors emanating from liquid manure. Liquid dairy manure is being treated with hydrogen peroxide and other chemicals that are available to the farmer. The chemicals are being added to liquid manure stored under anaerobic conditions in 5 and 55 gallon drums. The effectiveness of the odor control agents are evaluated by test panels on a 0 to 10 scale for presence of odor and offensiveness of the odor. Results of treating liquid manure with 6.5, 12.5, 25, 50 and 100 ppm of hydrogen peroxide show that 12.5 ppm of hydrogen peroxide suppressed hydrogen sulfide for one hour. Alamask 518 and 151A were the most effective in reducing odors in the liquid manure of the chemical agents tested to date. None of the chemical agents tested to date have completely eliminated malodors. The tests now in progress will evaluate the effectiveness of the additional compounds in controlling odors and also the loading rates required for odor control. These chemical agents will also be compared with hydrogen peroxide and Alamask 518 and 151A to determine which compound would be the most effective in controlling odors. Cost analysis for all the chemical agents tested is presented. Preliminary cost estimates on hydrogen peroxide and Alamask 518 and 151A indicate that chemical treatment is comparable or less than the cost of odor control by an oxidation ditch. (Ritter, et. al.-Delaware University)

### 2699 - A1, B1, E2 200

### LAND APPLICATION OF MANURES—WISCONSIN'S MANURE MANAGEMENT PLAN,

Extension Agricultural Engineer, Wisconsin University, 460 Henry Mall, Madison
L. R. Massie, R. D. Powell, R. E. Graves
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 385-388.

Identifiers: Waste management program, Land application, Application rates.

The production and related need to dispose of manure from a farm's livestock operation often is not compatible with the crop production schedule. A management plan has been developed to coordinate production and handling of manure with maximum utilization and minimum potential pollution. This paper describes, with examples, the manure production and utilization situation based on collectible data from each farm's records. The three major segments of data are: (1) Production of manure as related to kind, size, and number of animals, types of housing, and handling facilities, (2) Land use related to soils, conservation practices, crop rotations, acreages, and topography, and (3) Application rates of manure to the land related to kind of crop, nutrient removal by the crop, internal soil drainage, and timing of the application. Assessing the farm's manure handling situation in this way points up conflicts between livestock and crop production operations. However, these conflicts are overcome by this individualized farm plan. Each farmer can have a complete manure management program which determines the number of animals the farm can support based on the imposed limitations. Essentially, the farm has a manure management plan similar to a soil conserving or livestock production plan. Farmer acceptance was good. Farmers suggested ideas that were incorporated into the plan. Many described the plan as an assessment of the impact of their operation on the environment. (Massie-Wisconsin University; Merryman, ed.)

### 2700 - A1, B1, D2, D4, E2, F1 200

### IF YOU CANNOT SPREAD IT, TREAT IT!,

Babtie Shaw and Morton, 95 Bothwell Street, Glasgow, G27HX, Scotland
P M Wilson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 389-390

Descriptors Slurries, Waste treatment, Separation techniques, Effluent, Sludge, Aeration, Costs
Identifiers Land spreading, Swine

Land spreading of pig slurry is by far the most common means of disposal in the United Kingdom as well as being the cheapest form of disposal and providing a financial saving with respect to fertilizer requirements However, it is unlikely that this practice will be allowed to continue because of the serious organic pollution and inorganic enrichment of rivers and lakes resulting from runoff, danger of cross infection by pathogenic organisms and the ever-increasing number of complaints of smell Thus alternative means of disposal or utilization must be found The nature and extent of the processes required are determined by the degree of treatment needed and to some extent by the size of the piggery A system has been recommended where an effluent of about 50 mg-litre SS and 50 mg-litre BOD (50 50 standard) could be produced More complete treatment to a standard less than 30 20 would necessitate costly tertiary methods and unless substantial financial assistance were available these costs may be difficult to meet The system involves separation of fibrous solids by using vibrating screens, followed by extended aeration of the liquor and final settlement By-products of treatment include manageable, stable solids and sludges which can be spread on the land Final effluent can be used for irrigation or washwater Alternatively the local sewage authority may handle the final disposal step An approximate guide to the order of cost of treatment by this scheme is given Other treatment methods are discussed but many of these have been investigated only as far as the laboratory and pilot scale stage and insufficient information has been obtained in order to assess their performance and cost at the full scale level (Wilson-Scotland; Merryman, ed )

### 2701 - B1, C2, C3, E1 200
### EVAPORATION OF WATER FROM HOLDING PONDS,

Professor, Department of Agricultural Engineering, North Dakota State University, Fargo
G L Pratt, A W Wieczorek, R W Schottman, and M L Buchanan
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 391-394

Descriptors: Evaporation, Physical properties, Chemical properties, Separation techniques
Identifiers Holding ponds

The potential for using evaporation ponds as a method of disposing of animal wastes has been evaluated The goal was to develop a method for sizing ponds so all water from a waste disposal system can be disposed of by evaporation Liquid wastes, from approximately 20 head of cattle, were drained away from the solid wastes by gravity over a concrete floor Solids were scraped from the floor at intervals and disposed of separately The liquid was pumped to a pond The pond was lined with a 10 ml vinyl liner to eliminate the parameter of seepage The flow into the pond averaged 92.1 gal/day over a 4½ month period The evaporation rate from a floating pan was 0.3" higher than the recorded pond evaporation The evaporation rate from a Class "A" pan containing unpolluted water was 1.39" higher than the pond evaporation Generally all temperature values were similar Various factors, such as total solids, suspended solids, volatile solids, and Biochemical Oxygen Demand of the water were measured in the laboratory Evaporation from Class "A" evaporation pans generally has been found to run higher than from open bodies of water Several variables, such as lake size, temperature, wind, and solar energy will influence this A coefficient of 0 70 is commonly multiplied times the data recorded from the Class "A" evaporating pans to estimate evaporation from lakes Experience has shown that these coefficients may range from 0 70 to 0 80 An average figure of about 0 75 is given for Fargo Using the average evaporation figures from the tests carried out on the experimental pond from May 1 to September 15, 1973, it was found that a coefficient of 0 78 times the evaporation rate of the Class "A" evaporation pan located in Fargo gave a suitable design figure for the evaporation rate from a livestock waste disposal pond in this area (Pratt-North Dakota State University)

### 2702 - B2, D4, E2 200
### AN ECONOMIC AND MANAGERIAL EVALUATION OF MANURE FLUMING AND LAND APPLICATION SYSTEMS,

Agricultural Marketing Manager, Gorman-Rupp Co Box 1217, Mansfield, Ohio 44901
P B Bohley, C R Near, D Rasmussen
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 395-397

Descriptors Flumes, Lagoons, Costs, Iowa, Nebraska, Design
Identifiers Land disposal

The objectives of this project are to compare and evaluate the fluming, lagoon, land application system with other types of manure management programs extant During the summer of 1974, several beef confinement lots in western Iowa and eastern Nebraska were observed and evaluated Attention was directed towards cost of installation—including land, construction of buildings and lagoons, equipment, and personnel needed for operation Management requirements and techniques were observed and compared Feedlots ranged in size from 1,200-10,000 head capacity and optimum size was a factor in the evaluation of the various liquid manure systems in use Most lots were in rural locations, only three being close to suburban areas All confinement installations were less than three years old although most of the operators had been in business for a much longer period of time For purposes of evaluation, these manure systems are examined by component activities, i.e production-collection-holding-transfer-storage-land application Systems with single and multiple flumes were observed Building lengths varied from 500-1200 feet and lagoons, from 1½-4 acres surface area, ranged from immediately adjacent to several hundred feet distant Sequence of flushing is based on size and number of cattle, and on climate as well Some systems are on automatic operation and others on manual Automatic systems are evaluated for reliability but most operators prefer manual operation Lagoons are examined for accessibility, size, loading rate, build-up, and other pertinent factors Two land applications systems using lagoon supply are listed in the report—one using gated pipe and the other a volume gun sprinkler The paper appraises effluent return and the land use aspect from a mechanical and hydraulic standpoint (Bohley-Gorman-Rupp Co ; Merryman, ed )

### 2703 - B1, D1, E2, E3, F1 200
### ENERGETICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS,

Research Assistant, Agricultural Engineering Department, Illinois University, Urbana
H C Kim and D L Day
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 398-401

Descriptors Recycling, Costs, Liquid wastes, Fertilizers, Anaerobic digestion, Methane
Identifiers Energy expense evaluations, Waste management systems, Oxidation ditch, Refeeding

The objective of this study was to evaluate and compare major systems of livestock waste management on an energetic as well as monetary budget basis It is a literature and computational research study using a model to simulate swine enterprises marketing 4,000 hogs per year including farrow-to-finish production facilities The major waste management systems considered are: anaerobic storage of liquid manure using the manure as crop fertilizers; oxidation ditch treatment of liquid manure with refeeding of proteinaceous liquor; anaerobic digestion to produce methane gas and fertilizer; and drying with refeeding of dried manure The energy expense evaluations include all man-controlled inputs such as energy in materials and equipment appropriately amortized as well as the operating energy An energy input-output matrix developed by the University of Illinois Center for Advanced Computation is used to determine energy required for manufacturing processes Energy credits would account for energy in utilization methods such as for fertilizer, protein, methane, etc The analysis yields a net energy evaluation (profit or loss) for each system studied Tentative results rank the systems as follows for energetics and monetary economics (the lowest number is assigned to the best results, etc ) All methods gave a net energy loss except for anaerobic storage and spreading on land, which gave a slight net energy profit (1) Anaerobic storage and spreading Btu-1; $-1 (2) Anaerobic digestion for mathane Btu-2; $-3 (3) Oxidation ditch with refeeding Btu-3; $-2 (4) Drying and refeeding Btu-4; $-4 (Kim-Illinois University; Merryman, ed )

### 2704 - B1, C2, C3, D2, E2 200
### FIELD EVALUATION OF A SETTLING CHAMBER FOR SWINE WASTES,

Extension Agricultural Engineer, Province of Manitoba
E T Oatway, D D Schulte, and L Shwaluk
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p 402-404

Descriptors Separation techniques, Liquid wastes, Solid wastes, Waste storage
Identifiers Swine, Settling chamber, Land disposal

The swine facility studied is a 50 sow farrow-to-finish enterprise consisting of 4 units (farrow, weaners, feeders, dry sows) constructed in 1970 The units have partial slotted floors with pits 2 feet deep for the collection of wastes Each pit is fitted with a liquid-tight gate to control the flow of wastes Each pit is emptied by gravity flow into a main trench which conducts the wastes into two storage pits The storage pits consist of a concrete tank and an earthen pit in series The concrete tank functions as a settling chamber and storage for solids, and the earthen pit as a storage for liquids The system provides a low cost method of storing swine wastes for 6 months or longer The settling chamber requires clean out every six months The earthen liquid pit can be emptied by pump and irrigation or tank wagon Total and suspended solids, total and ammonia nitrogen, and phosphorus data has been collected and used to study the effectiveness of the pit arrangement as a solids separation method (Oatway-Canada)

### 2705 - A1, B1, D4, E1, F1 200
### LIVESTOCK AGRICULTURE IN THE STATE OF HAWAII--A REGIONAL APPROACH TO WASTE MANAGEMENT,

Department of Agricultural Engineering, College of Tropical Agriculture, Hawaii University, Honolulu
G M Wong-Chong, W I Hugh, J H Koshi, T Tanaka, C Schlottfeldt
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, Uni-

versity of Illinois, Urbana-Champaign, April 21-24, 1975, p. 405-407.

Descriptors: Hawaii, Economics, Farm management.
Identifiers: Regional Wastes Management, Composting.

Livestock agriculture in the State of Hawaii is influenced by several factors: (a) importation of almost all feed stuffs from mainland, (b) concentration of the state's population (about 75 per cent) in Honolulu, (c) high cost of inter-island transportation, and (d) increasing urban development encroaching on agricultural land. Because of the population density in Honolulu, a major fraction of the livestock agriculture is on Oahu; in fact, some 50-70 per cent of the State's livestock activities is in the Waianae-Mikilua-Lualualei (3500 acres) area. Unfortunately, this area is presently experiencing increasing pressures from urban developers and the resulting demands for more rigid wastes management. The farms in the parcels of land (2-15 acres). In many cases land disposal of wastes is not an effective alternative and other treatment processes are too expensive. In the Waianae-Mikilua-Lualualei area, the feasibility of a regional wastes management scheme was examined. This regional approach was to collect all the animal wastes at a centralized composting site. The paper discusses (a) The waste collection system. (b) The composting process alternatives—windrow vs. forced aeration. (c) The market potential for compost in the State. (d) The economics of the proposed system. (e) The problems of disease transmission control. (f) The institutional problems of getting such a scheme to work. (Wong-Chong—Hawaii University)

### 2706 - A2, B1, F2 200

### ESTIMATING QUANTITY AND QUALITY OF RUNOFF FROM EASTERN BEEF BARNLOTS,

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W. M. Edwards and J. L. McGuinness
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 408-411.

Descriptors: Agricultural runoff, Feedlots, Cattle, Ohio.
Identifiers: Prediction equation, Runoff quantity, Runoff quality.

Proposed EPA guidelines for feedlot effluent require that by 1983 all feedlot operations have the capacity to store runoff from 25-year, 24-hour rainfall. In view of these requirements, an analysis was made of runoff volume and quality from a typical unpaved beef barnlot in eastern Ohio. The measurements were made over a 4-year period on a 0.4 acre, 60 head barnlot watershed at the North Appalachian Experimental Watershed, Coshocton, Ohio. A prediction equation for daily runoff volume was developed by a multiple regression analysis of 181 runoff events. Rainfall amount and antecedent moisture content of the surface layer accounted for 75 per cent of the storm runoff variability. Joint probabilities of various amounts of rainfall occurring with different antecedent soil moisture conditions were used to define maximum, minimum and mean daily runoff volumes at different times of the year. Inclusion of a rainfall intensity variable in the multiple regression did not improve the runoff volume prediction. The presence or absence of cattle in the lot at the time of the event also had no effect upon prediction of runoff volume. The seasonal distribution of N, P, K and BOD concentrations in runoff were determined. Using long-term weather records, water quality data, and the runoff prediction equation, runoff volume and associated nutrient transport for 10- and 25-year frequency storms occurring at different times of the year were also estimated. The rainfall prediction was also used to extend runoff relations to paved lots. (Edwards and McGuinness-USDA)

### 2707 - A1, B1, E2 200

### A COMPUTER SIMULATION OF STORAGE AND LAND DISPOSAL OF SWINE WASTE,

Department of Agricultural Engineering, Arkansas University, Fayetteville
C. R. Mote and E. P. Taiganides
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 412-415.

Descriptors: Waste storage, Waste disposal, Performance.
Identifiers: Swine, Computer simulation, Land disposal, Cropping systems.

Crop production cycles, soil trafficability conditions, and variations in the animal population determine the performance of storage and land disposal systems for wastes from confinement swine production units. A computer simulation program was developed which simulates these factors and their interactions. Studies made with the program indicate that: (1) a given capacity storage tank can provide storage capacity for more of the waste produced over a period of time if emptying operations are initiated well before the tank is completely full, (2) the types of crops being grown on the land available for waste disposal affect the storage capacity required to prevent overflow, and (3) the net annual cost of waste storage and land disposal systems may be reduced by modifying the cropping pattern for a given acreage. A total of 63 different waste storage and land disposal situations was studied with the computer simulation program. The study included combinations of seven storage capacities, three cropping programs, and three criteria for initiating the removal of waste from storage. For each of the 63 different conditions the behavior of the system was simulated for a five-year operating period. The performance of the system for each of the 63 five-year operating periods was compared in order to observe the effect of variations in storage capacity, cropping program, and hauling initiation criteria. (Mote and Taiganides-Arkansas and Ohio; Merryman, ed.)

### 2708 - A2, B2, E2 200

### MANAGEMENT OF IRRIGATION FOR DISPOSAL OF FEEDLOT RUNOFF IN COLD CLIMATES,

Assistant Professor, North Dakota State University, Fargo
R. W. Schottman, C. W. Thoreson and J. K. Koelliker
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 416-420.

Descriptors: Irrigation, Agricultural runoff, Feedlots, North Dakota, Model studies, Design, Climates, Pumping.
Identifiers: Detention pond.

Management of the pumping of livestock runoff to be used for irrigation is considered for several locations in North Dakota. Pumping durations, pumping rates and detention pond size and shape are simulated for stations having contrasting climatological conditions. Runoff events are predicted and are compared to the 10-year and 25-year, 24 hour storms for each station. All stations are characterized by at least a 90 day period of continuously frozen conditions and by a growing season of approximately 120-130 days. Runoff is predicted using a model similar to that developed by Larson at the University of Minnesota. The model has been expanded to allow specification of pumping rates and duration as well as pond size and shape. At least 30 years of daily precipitation and temperature records were used as input data for each station. The SCS runoff model is used as the basis for predicting the size of each runoff event. Runoff and pumping programs for two commercial feedlot operations were monitored and the observed water levels and runoff events were compared with predicted values. Design recommendations are proposed for the rather unique climatological conditions encountered in North Dakota. The model's applicability to other climatological conditions is also demonstrated. (Schottman, et. al.-North Dakota and Kansas)

### 2709 - A2, B1 200

### RUNOFF CONTROL FACILITIES FOR BEEF CATTLE FEEDLOTS IN EASTERN NEBRASKA,

Agricultural Engineering Department, University of Nebraska
J. A. Nienaber, C. B. Gilbertson, T. E. Bond, and J. L. Gartung
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 421-425.

Descriptors: Agricultural runoff, Feedlots, Cattle, Nebraska, Research and development, Design, Performance.
Identifiers: Runoff control.

This paper is a final report of five years research on feedlot runoff control facilities on eight Eastern Nebraska research, and cooperator sites. Runoff quantity and quality, solids transported and solids removal efficiencies are discussed in terms of system design, performance, and management. Research demonstration site for a 4000 head feedlot was installed in 1973 based on the 5 year results. The design of this EPA sponsored project will also be reported. (Nienaber, et. al.-Nebraska University)

### 2710 - A2, B2, E1 200

### DESIGN RUNOFF VOLUME FROM FEEDLOTS IN THE SOUTHWESTERN GREAT PLAINS,

Agricultural Engineer, USDA, ARS, Water Quality, Management Laboratory, Route 2, Box 322A, Durant, Oklahoma.
V. L. Hauser
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 426-428.

Descriptors: Design, Agricultural runoff, Feedlots, Texas, Economics.
Identifiers: Southwestern Great Plains, Runoff control, Soil Conservation Service runoff equation.

The design of feedlot pollution control systems required an estimate of the runoff volume to be controlled. Federal and State regulations presently rely on the Soil Conservation Service (SCS) equation for runoff estimation. They also rely on the Weather Bureau Technical Publication No. 40 (TP 40) for estimates of the design storm, which, in Texas, is 24-hour rainfall expected once in 25 years. This paper examines the accuracy of these present design procedures. A recently published equation for runoff derived from runoff measurements on a feedlot at Bushland, Texas (near Amarillo) was tested against the more widely used SCS equation. Runoff was computed by each equation for each day with rain in a 35-year rainfall record from Bushland and in an 82-year rainfall record for Amarillo. These computed runoff amounts were analyzed to derive return frequency of runoff amount for the new Bushland equation and for the SCS equation. The results show that the presently used design method may compute up to 3 times as much runoff as the new Bushland equation. In addition, significant differences were found between 24-hour, 25-year return frequency rainfall found in TP 40 and the actual record from the two stations analyzed. Over estimation of the design runoff amount from feedlots causes wasteful expenditure in both runoff reservoir construction and the purchase of a disposal system. This research indicates the need for revision of design methods and requirements of law. (Hauser-Oklahoma; Merryman, ed.)

### 2711 - A2, B1 200

### QUANTITY AND QUALITY OF BEEF FEEDYARD RUNOFF IN THE GREAT PLAINS,

Agricultural Engineer, ARS, USDA, Southwestern Great Plains Research Center, Bushland, Texas
R. N. Clark, C. B. Gilbertson and H. R. Duke
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 429-431.

Descriptors: Agricultural runoff, Cattle, Great Plains.
Identifiers: Runoff quantity, Runoff quality.

The Great Plains Region has become the world's largest confined cattle feeding area during the last 10 years. The region increased fed cattle production from 6 million in 1963 to over 14 million in 1973. Also, during the last decade, water quality control regulations have been established requiring the impoundment of runoff and waste water from these feedyards. Runoff studies were begun about 1967 at several locations throughout the Great Plains in order to characterize feedyard runoff as to quantity and quality. The objective of this paper is to combine these data and present them in a uniform format. Rainfall-runoff relationships are presented from seven feedyards from eastern Nebraska and eastern Colorado to South Texas. In all cases, the rainfall-runoff relationship was linear; however, the slopes varied from 0.36 to 0.86. Runoff did not begin until at least 1 cm (0.4 inch) of rainfall had occurred. The quality of runoff was quite variable at each location depending on rainfall intensity and duration, time since last runoff, and stocking rate. However, noticeable differences were found between the various research locations. The concentration of salts was less in eastern Nebraska and increased inversely with total rainfall to highest concentration in West Texas. (Clark, et. al.-Texas, Nebraska, and Colorado)

### 2712 - A1, B1, C2, C3 200

### PROPERTIES OF SOLIDS FROM STACKED MANURE,

Assistant Professor, Department of Agricultural Engineering, Wisconsin University, Madison
J. C. Converse, C. O. Cramer, G. H. Tenpas, and D. A. Schlough
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 432-436.

Descriptors: Solid wastes, Liquid wastes, Separation techniques, Waste storage, Chemical properties, Physical properties, Land application.
Identifiers: Manure stacking, Detention ponds, Fly control.

Over winter storage of manure is receiving much emphasis because of concern for environmental quality and desire of the livestock operator to reduce drudgery of daily hauling. Stacking manure is most appropriate for stanchion type dairy facilities. This paper summarizes three years of data from three different stacking systems. The three systems include a covered bunker type storage for 32 cows, a platform type storage with swinging slide elevator for 28 cows and a platform type storage with a manure blower for 26 cows. Separation of liquids from solids was used in all three systems using drains and porous media. Liquids were stored in a detention pond for later application to crop land. Stacking was done year around with removal during spring and fall. Each system was evaluated for both winter and summer periods for solid and liquid volumes, physical and chemical characteristics of solids and liquids, stackability of manure and fly problems. Liquid runoff from stacks has high pollution potential and must be kept out of bodies of water. Liquid volumes varied with rainfall, amount of manure in storage and ability of liquid to separate from solids. A porous media is required between the manure and concrete floor of storage unit. Solid storage volume requirements were about 1.6 cu. ft.-1000 lb. of live weight. Chemical fly control is ineffective and uneconomical for summertime stacking, but biological fly control is effective and economical. Stackability is dependent upon quantity of straw used and time of year stored, with wintertime stacking superior to summertime stacking. This information will provide the design engineer with tools to adequately design solid manure storage facilities. (Converse-Wisconsin University)

### 2713 - A6, B2, C2, C3, D4, E2 200

### MANAGEMENT OF A FLUSHING-GUTTER MANURE-REMOVAL SYSTEM TO IMPROVE ATMOSPHERIC QUALITY IN HOUSING FOR LAYING HENS,

Department of Agricultural Engineering, Iowa State University, Ames
R. L. Fehr, and R. J. Smith
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 437-440.

Descriptors: Waste water treatment, Lagoons, Recycling, Poultry, Air pollution.
Identifiers: Air quality.

An 1100-bird layer house at Iowa State University has been remodeled by installing a flushing-gutter manure-removal system. There are three ranks of cages in the building with sloping metal trays under the outer ranks of cages and a central wastewater holding pit. Wastewater is pumped from holding pit to dosing-syphon tanks for flushing metal trays. Wastewater in the central holding pit is periodically pumped 2000 ft. (610 m) to an anaerobic lagoon. Overflow from the anaerobic lagoon enters an aerobic lagoon; liquid from this second lagoon is recycled to the central holding pit. Because frequent manure removal aids in odor control, ammonia and hydrogen-sulfide-gas levels are being monitored to determine optimum system management. The management consists of varying the interval between emptying of the central holding pit, and varying the interval between the flushings of the metal trays. With reduced odor levels in the house, it is feasible to reduce ventilation rates. Winter ventilation rates are being lowered below the recommended 1/2 cfm to 1/8/1/4 cfm (p.014 $m^3$-min to 0.0035-0.007$m^3$-min) per bird. Temperature, humidity and dust levels are also being recorded at various points in the house. Wastewater pumped to the lagoons and recycled is being monitored to determine the effectiveness of the treatment system. COD, total solids, dissolved solids, and ammonia-nitrogen levels are being measured. These measurements are also being made on wastewater in the house to determine interaction between these parameters and atmospheric environment. Success of the system is related both to improved environmental control around the birds and to mechanization of manure handling. (Fehr-Iowa State University)

### 2714 - B1, E2 200

### PERFORMANCE OF SCREW CONVEYORS FOR UNLOADING SLUDGES FROM FIELD TRANSPORTS,

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M. Weil and A. Higgins
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 441-443.

Descriptors: Equipment, Performance, Economics.
Identifiers: Land disposal, Screw conveyors, Field transports.

Equipment has been developed to incorporate a wide range of biodegradable wastes directly into the upper 8 inches of the soil by Plow-Furrow-Cover, Sub-Sod-Injection, and Ridge and Furrow. Physical properties of wastes unloaded from this equipment may vary from thin slurries to caked materials with up to 75 per cent solids (wet basis). There are economic advantages to handling materials with a solids content of 15 per cent or greater. A field transport for such material must be water tight and readily unload sludge with a wide range of physical properties. A review of literature indicates the difficulty of describing the physical properties of sewage sludges. Per cent solids does not adequately indicate the handling characteristics of this material. Field tests of equipment have shown that screw conveyors are well suited for unloading sludges from field transports. Very little has been published about actual performance of screw conveyors for conveying sewage sludge. Extensive tests using sewage sludges with varying physical properties were made on 9-inch-diameter helicoid flight and 9-inch-diameter ribbon flight screw conveyors. Mass flow rate and horsepower requirements were determined with varied screw conveyor slope and rotational speed. Less extensive performance tests were conducted on 6-inch-diameter helicoid flight and 12-inch-diameter ribbon flight screw conveyors. The performance data collected were compared to handbook performance data. (Weil-Rutgers)

### 2715 - E2 200

### EQUIPMENT FOR INCORPORATING ANIMAL MANURES AND SEWAGE SLUDGES INTO THE SOIL,

Professor of Agricultural Engineering, Biological and Agricultural Engineering Department, Rutgers State University, New Brunswick, New Jersey
C. H. Reed
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 444-445.

Descriptors: Equipment, Animal wastes, Sludges, Physical properties.
Identifiers: Land disposal, Plow-Furrow-Cover, Sub-Sod-Injection, Ridge and Furrow.

Soil, land, and environment can be improved when biodegradable wastes are recycled by incorporation directly into the aerobic layer of the soil. During the last 9 years, equipment has been designed, assembled, or adapted from commercially available components, and field tested. Techniques for incorporating animal wastes and sewage sludges directly into the soil in one or two passes over the ground are Plow-Furrow-Cover, Sub-Sod Injection, and Ridge and Furrow. The physical properties of these wastes have varied from thin slurries of animal manures and septic tank pumpouts (2 per cent solids), to to semisolid sludges (15 to 25 per cent solids), animal manure with bedding; and sand-bed-dried sewage cake with up to 75 per cent solids, which is the most difficult of all to unload. The equipment has incorporated up to 200 tons per acre at a ground speed of 3 mph. Two types of trailer chassis have been developed to be used with a standard 50 hp farm tractor. The first has a gooseneck tongue which provides space for mounting the plow, injector or ridge-and-furrow opener on the 3-point-hitch of the tractor. The most recently developed unit has these components mounted on the trailer chassis. Preliminary field testing of this unit has indicated some advantages over the excellent performance of the chassis with the gooseneck tongue. As a result of extensive field testing, a water-tight tank with appropriate accessories has been designed and is being assembled. This equipment is designed to unload any of the aforementioned materials at a minimum rate of 60 cfm. This tank may be either trailer or truck mounted. (Reed-Rutgers)

### 2716 - B1 200

### SHORTEST PATH NETWORK ANALYSIS OF MANURE HANDLING SYSTEMS TO DETERMINE LEAST COST–DAIRY AND SWINE,

Department of Agricultural Engineering, McGill University, Ste. Anne de Bellevue, Quebec H9X 3M1, Canada
J. R. Ogilvie, P. A. Phillips and K. W. Lievers
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 446-451.

Descriptors: Structures, Swine, Dairy industry.
Identifiers: Canada, Network analysis techniques, Costs, Equipment.

Network analysis techniques were used to assess alternatives in manure management systems. The shortest path network analysis (SPNA) was adopted. This modification of CPM and PERT techniques yields the least cost when the duractions of activities are expressed as capital, operating or energy costs. The objective was to evaluate certain existing practices to determine least cost to the farmer using SPNA. Equipment and structures for manure handling comprising 250-300 elements (such as gutter cleaners, tractor loaders, manure tanks and tankers) were analyzed and data is presented in graphical and tabular form. These results show least cost among the various complete systems utilizing these components for particular conditions and scale of operations. The components for dairy cattle are based on the elements found in the plans recommended for the Canada Plan Service. Most cost inputs were obtained by field observations. Similarly swine systems are based on existing Plan Service recommendations but various processing systems have also been included. (Ogilvie-McGill University)

### 2717 - B1, D2 200

### APPLICATION OF THE ROTATING FLIGHTED CYLINDER TO LIVESTOCK WASTE MANAGEMENT,

Department of Agricultural Engineering, Oregon State University, Corvallis
J. R. Miner and W. E. Verley
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 452-455.

Descriptors: Biological treatment, Livestock, Separation techniques, Aeration, Sedimentation, Slurries, Dairy industry.
Identifiers: Rotating flighted cylinder, Swine, Oxygen transfer.

A solid-liquid separator has been devised which utilizes sedimentation in a unique physical arrangement. The device consists of a tube mounted on a slight incline. On the interior surface of the tube, a spiral fin, similar to a deep screw thread, is attached, forming a series of small sedimentation basins within the tube. Solid-bearing water is introduced into the tube approximately one-third the tube length from the upper end. As the water flows over the fin and through the sedimentation basins, settleable solids are deposited. As the tube is slowly rotated, the solid fraction is transported out the upper end. The nature of the solid stream depends upon the design of the upper wraps of the fin. In addition to solid-liquid separation, the fin on this device performs an aeration and biological treatment function similar to the disks of a rotating biological contactor. Oxygen transfer rates for the rotating flighted cylinder have been measured and are a function of flow rate and rotational speed. In this paper, operating data are included for the separation of solids from both swine and dairy manure slurries using 8 and 24 inch diameter metal tubes. Oxygen transfer studies were conducted using an 4 inch diameter tube of PVC plastic with fiberglass fins. Data are also provided from biological waste treatment studies using this latter tube treating a dairy manure slurry. (Miner and Verley-Oregon and Kansas)

### 2718 - A1, B1, D2, D4 200

### SETTLING CHARACTERISTICS OF SWINE MANURES AS RELATED TO DIGESTER LOADING,

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J. R. Fischer, D. M. Sievers, and C. D. Fulhage
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 456-458.

Descriptors: Separation techniques, Anaerobic digestion, Phosphorus, Potassium, Slurries, Nitrogen, Sedimentation, Design.
Identifiers: Settling characteristics, Swine, Gutter-flush system.

Loading of an anaerobic digester is critical for its successful operation. When a gutter-flush system is used to collect swine waste, much of the flush water must be wasted and the solids concentrated before allowing the waste slurry to enter the digester. One of the simplest and most economical means of concentrating solids is sedimentation. For proper digester loading, it is desirable to know the fraction of removal of volatile solids, organic nitrogen and total solids that can be achieved by settling. From a potential fertilizer value, it is desirable to know the fraction of phosphorus and potassium. A 3 x 4 x 4 factorial in a split-split plot design with 3 replications was utilized using a 6-foot deep, 5½" ID settling chamber. Slurries of .05, .5 and 5 per cent solids were used. Samples were taken at 1, 10, 100 and 1000 minutes and analyzed for total solids, volatile solids, organic nitrogen, total phosphorus and potassium. Samples were taken at depths of 0, 2, 4 and 6 foot from the top of the settling chamber. After one hour of settling at the 6-foot depth, 40 per cent of the total solids were removed for the .5 per cent solid slurry and 29 per cent of the total solids removed for the .05 per cent slurry. The thicker slurries exhibited better settling. An average total phosphorus removal of 47 per cent and 32 per cent at 100 minutes was achieved for the .05 and .5 per cent slurries respectively. For the .05 per cent slurry, an average removal of organic nitrogen for the 0, 2 and 4-foot depths at 100 and 1000 minutes was 32 and 44 per cent respectively. Little settling of organic nitrogen occurred after 100 minutes for all slurries. Potassium being largely dissolved was not readily removed from the slurry. Less than 5 per cent removal was achieved at any depth for the 1000 minute time period. (Fischer, et. al.-Missouri; Merryman, ed.)

### 2719 - B1, D2, E3 200

### A ROTATING CONICAL SCREEN SEPARATOR FOR LIQUID-SOLID SEPARATION OF BEEF WASTES,

Department of Agricultural Engineering, Oklahoma State University, Stillwater
R. Shirley and A. Butchbaker
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 459-462.

Descriptors: Separation techniques, Design, Slurries, Cattle.
Identifiers: Rotating conical screen separator, Liquid-solid separation, Refeeding, Oxidation ditch.

The objective of this research was to remove the undigestible and coarse material from aerated beef waste slurries. Removal of hair and undigested corn particles was desired in order to improve the pumpability of the slurry and to concentrate the finer and more protein rich particles into one medium for refeeding studies. A rotating conical screen separator was designed, constructed, and tested. The separator had a conical screen sloped at a 45 degree angle below the horizontal. The screen was rotated about a vertical axis at a low RPM. Influent from an oxidation ditch was introduced at the top of the screen. The course solids remained on the screen and slid down the screen until slung off by centrifugal forces. The liquid fraction penetrated the screen and was collected by a funnel attached to the screen. The screen mesh had an opening of 0.10 inches and screened about 10.37 per cent of the solids (mainly hair and coarse grain particles). The collected slurry was rich in protein matter and very pumpable. The theoretical maximum power required at a flow rate of 142 lb-min (64.5 kg-min) was 0.4 watts. A peripheral screen speed of 168 ft-min (51 m-min) gave optimum separation of the waste. (Shirley and Butchbaker-Oklahoma State University)

### 2720 - B1, D2 200

### EVALUATION OF SOLIDS SEPARATION DEVICES,

The Ohio Agricultural Research and Development Center, Wooster, Ohio
J. W. Shutt, R. K. White, E. P. Taiganides and C. R. Mote
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 463-467.

Descriptors: Separation techniques, Screens, Settling tanks, Chemical oxygen demand, Biochemical oxygen demand.
Identifiers: Liquid cyclone, Solids removal, Total solids, Total volatile solids, Total suspended solids.

Stationary and vibrating screens, a liquid cyclone, a circular settling tank, and laboratory scale devices were evaluated for their efficiency of solids removal from a stream of untreated and treated wastewater. Separation efficiencies were measured by changes in total volume, TS, TVS, TSS, BOD, and COD. For the stationary screen, two different screen opening sizes (0.040 and 0.060 inch sieves) were tested under four different flow application rates ranging from 26 to 80 gpm. Four screen size openings (0.0047, 0.0065, 0.0084, and 0.0153 inches) and three application rates (range: 9-30 gpm) were used in the tests run with a vibrating screen. Results indicate that for each screen size there is an optimum application rate. A 3-inch diameter liquid cyclone with three different underflow nozzle diameters (0.125, 0.188 and 0.250 inch) was tested at four different pressure drops (20, 40, 60, and 80 psi). The tests show there is an optimum pressure drop at which the liquid cyclone should be operated. The liquid cyclone accomplished an 18 fold increase in TSS concentration of solids in the influent wastewater stream. Removal efficiencies of TSS, COD, and other parameters with settling tanks are affected by detention time, overflow rate, suspended solids concentration in wastewater, and degree of pretreatment. Both field installations and laboratory models were studied. Suspended solids removal of over 90 per cent were consistently achieved with COD removal in the range of 60 per cent. Solids removal from wastewater streams with TSS of 2-4 per cent occurs as a zone settling process. As the initial TSS concentration in the wastewater stream increased, unit area needed for settling also increased. (Shutt, et. al.-Ohio; Merryman, ed.)

### 2721 - B1, C2, D2 200

### IN-HOUSE HANDLING AND DEHYDRATION OF POULTRY MANURE FROM A CAGED LAYER OPERATION: A PROJECT REVIEW,

Department of Agricultural Engineering, Michigan State University, East Lansing
M. L. Esmay, C. J. Flegal, J. B. Gerrish, J. E. Dixon, C. C. Sheppard, H. C. Zindel, and T. S. Chang
Managing Livestock Wastes, Proceedings 3rd Inter-

national Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 468-472.

Descriptors: Poultry, Dehydration.
Identifiers: Flash-type dryer.

A manure drying system involving caged layers with daily manure collection, air drying and final dehydration in a flash-type dryer has been studied at Michigan State University. The system was a commercial-type poultry building with four rows of wire, triple deck, cages, 21.95 meters (72') long with dropping boards for the top two decks. The cages were 30.48 cm by 40.64 cm (12" x 16"). One-half of the cages contained four birds per cage. This resulted in a startling flock of 5,280 birds. Droppings from the upper two cage rows were hand scraped daily to the pit below the bottom cage row. A cable-blade scraper removed these droppings onto a continuous conveyer belt in a drying tunnel. Droppings remained on the belt approximately twenth-four hours. Then the droppings were conveyed into a flash-type dryer. Drying took place on dropping boards, in the tunnel, and in the flash-type dryer. Drying on the dropping boards can reduce the moisture content of the manure to 65 per cent (W.B.) or less. After drying in the tunnel, moisture content can be reduced to 30 per cent (W.B.) or less. Outside weather conditions influence drying. The above figures are for summer conditions. For winter conditions, respective values of 72 per cent and 70 per cent are more representative. Spillage from waterers, etc. can also influence these figures. The ventilating air of a poultry house can be used to remove moisture from manure. In-house drying removes the largest portion of water. Drying from a belt in a tunnel is very effective under summer conditions. (Esmay-Michigan State University; Merryman, ed.)

### 2722 - B1, D2, E2 200

### DRYING OF POULTRY MANURE--AN ECONOMIC AND TECHNICAL FEASIBILITY STUDY,

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J. B. Akers, B. T. Harrison, and J. M. Mather
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 473-477.

Descriptors: Economics, Equipment, Poultry, Feasibility studies, Fertilizers.
Identifiers: Dried poultry manure, Refeeding.

The current United Kingdom interest in dried poultry manure originates from: (1) Shortage of protein in desirable meat form, (2) Realisation of the developing animal feedstuffs possibilities of poultry manure in the light of inflating prices of conventional animal feedstuffs, (3) Developing potential of poultry waste as a fertilizer in view of the recent and continuing escalations in compound fertilizer prices, and (4) Continuing development of intense husbandry of poultry and the concomitant waste disposal problem. A detailed analysis of the various types of dryer suitable for manure is presented. Pneumatic conveying, rotary drum and batch agitated driers were considered technically most suitable and possible improvements suggested. Costings are presented on a realistic basis, i.e. current costs, which include cost of capital for equipment and installation, maintenance, depreciation and labour. Costings show the economic advantages accruing from large scale operation and illustrate when small scale driers can become economically viable. Results are presented for scales of operation between 10-4 and 10-6 layers. Further costings are presented for manure which has been dewatered before drying. Both fuel oil and natural gas have been considered as fuels, and also the effects of variation in fuel costs. An assessment has been made of the suitability of different drying schemes to various applications and farming situations. (Akers, et. al.-United Kingdom)

### 2723 - B1, D2 200

### DRYING DAIRY WASTES WITH SOLAR ENERGY,

Department of Agricultural Engineering, California University, Davis
B. Horsfield
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 478-480.

Descriptors: Drying, Costs, Composting, Recycling.
Identifiers: Dairy wastes, Solar energy.

The author has previously carried out a computer simulation study to determine the feasibility of using solar energy on a year around basis to dehydrate animal wastes. The objective of this experiment was to verify those computer simulation results. The experimental procedure consisted of loading, at regular intervals, two small plastic greenhouses with fresh dairy wastes. The loading rates, i.e., pounds of wet manure per square foot per day, were established from experience gained with the computer simulation studies. The wet manure was placed in the greenhouses and carefully mixed in with the partially dried contents in an attempt to create a homogenous material. In addition to mixing in the wet material, the entire contents of each greenhouse was thoroughly mixed on an approximately weekly basis to insure that the contents remained in an aerobic condition. The wet manure was weighed and sampled for moisture content at the time of loading and the contents of the greenhouses were periodically sampled to determine moisture content. In addition, temperatures of the drying mass were periodically recorded because they provided an indice of aerobic activity. The results indicate that the partially dried dairy wastes can maintain thermophilic temperatures for prolonged periods and that composting contributes to dry matter loss as well as energy for evaporation. A comparison of the recorded solar energy input was made to the amount of moisture loss in order to determine the efficiency of the solar collecting apparatus. The results indicate that such a solar drying procedure is feasible if a mechanism is available for thoroughly mixing the wet manure with the contents and for maintaining aerobic conditions. A projection is made of the capitol investment and operating costs required for such a concept to be applied to a typical dairy operation. (Horsfield-California University; Merryman, ed.)

### 2724 - B1, D2, D4 200

### HIGH-RATE MECHANIZED COMPOSTING OF DAIRY MANURE,

Department of Agricultural Engineering, Maryland University, College Park
J. W. Hummel and G. B. Willson
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 481-484.

Descriptors: Design, Model studies.
Identifiers: Composting, Dairy manure.

Research was initiated to investigate mechanized aerobic composting. Research objectives were: (1) to design and develop an alternative method for reduction and/or utilization of livestock production wastes, (2) to investigate the applicability of this method to particular livestock production units for the control of air and water pollution, and (3) to develop and investigate alternative uses for these "wastes." Based upon the laboratory study of this concept, a pilotscale mechanized composting system has been designed and placed in operation at the University of Maryland Dairy Barns on the College Park Campus. Wastes (bedding, urine, and feces) from the 80-cow milking herd housed in stanchion barns are transferred by conveyor to the compost system on a daily schedule. The compost channel is sized to accept and retain these wastes for a 15-day period. During this time, the wastes are aerated continuously and stirred daily by an elevating mechanism which traverses the length of the channel. Each traverse of the elevating mechanism moves the wastes an increment of the channel length, resulting in a semi-continuous flow system. Thus, the channel is charged with raw wastes at one end, and the partially composted material is removed at the other end and moved to a programmed windrow to complete composting using natural convective aeration. Operational problems encountered and modifications made to the system during a 1.5-year operating period are discussed. Results obtained with this pilot system led to the conclusion that the wastes are reduced and more readily handled and utilized. (Hummel-Maryland University; Merryman, ed.)

### 2725 - B3, D4 200

### AEROBIC COMPOSTING--NEW BUILT-UP BED TECHINQUE,

Department of Agricultural Engineering, Ohio State University, Columbus
D. P. Stombaugh and R. K. White
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes—1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 485-489.

Descriptors: Aerobic conditions, Equipment, Design, Performance.
Identifiers: Composting, Swine.

A new aerobic composting system has been constructed and evaluated using swine waste. The built-up bed, aerobic composter provides both treatment and storage capability and should be adaptable to other animal wastes. The upper layers (top 30 to 40 cm) of the waste material stored in a large bin are tilled, mixed and leveled to provide uniform conditions and an adequate oxygen supply for rapid aerobic composting. With daily addition of 3 cm of waste over the bin surface, the waste undergoing most rapid composting is located in the upper 30 cm, while partially stabilized compost is allowed to ripen beneath the layers being tilled and is not aerated. Observations of machine and composter performance indicated that the tillage device as designed adequately mixes, aerates and levels in one or two passes (depending on the frequency of tilling) without clogging. Once a manure depth of 20 to 30 cm was obtained in the compost bin, process temperatures of 50 to 70 degrees C were rapidly developed and maintained. With appropriate limits placed on loading rates, type and condition of manure and duration, frequency and depth of tilling, satisfactory composting rates were maintained. Large decreases in moisture content and volatile solids, as well as pH measurement, C:N ratios, and observations of odors and compost appearance indicated that this new technique provides an alternative method for treating and storing solid livestock waste. (Stombaugh-Ohio State University; Merryman, ed.)

### 2726 - A1, B2, D4 200

### CONSERVATION OF NITROGEN IN DAIRY MANURE DURING COMPOSTING,

Agricultural Engineer, ARS-USDA, College Park, Maryland
G. B. Willson and J. W. Hummel
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 490-491.

Descriptors: Nitrogen, Dairy industry.
Identifiers: Composting.

Composting has been shown to eliminate undesirable odors, kill week seeds, and improve handling characteristics for dairy manure. However, nitrogen can be lost during composting. This research was conducted to determine the potential for nitrogen conservation through process control. A bulking material must be added to fresh manure to develop porosity for air movement and rapid aerobic thermophilic composting. Different levels of sawdust, straw, perlite and compost were added as bulking materials. Results are reported on 18 tests in bins with a capacity of 30 cubic feet and 52 tests in bench digestors with a capacity of one-third cubic foot. Spot checks were made in a pilot composter, composting the manure from an 80 cow dairy herd to verify laboratory results. The effect of type and quantity of bulking material on aeration and on loss of nitrogen will be discussed. Other properties that will be reported include, ammonia, nitrate, chemical oxygen demand, volatile solids and pH. The composting process can be managed to conserve nitrogen in dairy manure. Due to the reduction in volatile solids during processing the nitrogen concentration may be greater in compost than in raw manure. (Willson-USDA; Merryman, ed.)

### 2727 - B3, D2, D4 200

### COMPOSTING SWINE WASTE,

Department of Biological and Agricultural Engineering, Rutgers State University, New Brunswick, New Jersey
M. E. Singley, M. Decker, and S. J. Toth
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 492-496.

Descriptors: Yields.
Identifiers: Composting, Swine, Windrow technique, Bulking material.

Early tests of composting of swine waste using the windrow technique demonstrated that swine waste is a dense material that excludes air resulting in a lengthy composting time. After turning a windrow with the Roto-Spreader, a commercial composting machine, the incorporated oxygen disappeared in an hour or less. To reduce bulk density and allow air movement in the waste, a bulking material was added. In eleven windrow tests using different compositions of bulking materials and dense wastes, composting time was reduced significantly. The bulking material was either street refuse delivered by compactor truck or discard material collected from a shaker separator. Average composting time to reach temperature decline and suitable granulation for shaker separation for the last seven windrows was four weeks and four days. Windrows requiring the shortest time, three weeks and five days, were composed of approximately 75 per cent swine waste and 25 per cent street refuse by volume. A windrow of 50 per cent swine waste and 50 per cent bulking material collected from the shaker separator required six weeks. Windrows were turned twice daily on week days using the Roto-Shredder for an average total of 45 times. No separation of non-biodegradable material was made prior to composting. During turning, the glass was broken into fine pieces, the metals hammered into compact shapes, and the plastic shredded. As a result, the usable compost was easily separated from the material to be discarded. The yield was roughly 50 per cent compost with a high inert material content and 50 per cent discard. (Singley-Rutgers)

### 2728 - A1, B2, D4 200

### LIQUID COMPOSTING OF DAIRY MANURE,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 497-500.

Descriptors: Liquid wastes, Dairy industry, California, Equipment, Costs.
Identifiers: Composting.

The Santa Ana River basin of California has a total dairy cow population of approximately 174,000. Most of these cows are confined to a relatively small portion of the basin in the vicinity of Chino and Corona where the wastes from these cows burden the basin groundwater resources. The dairies are confronted with discharge requirements and expensive treatment and disposal alternatives. With EPA and local funding, a study was undertaken to determine the technical and economic feasibility of treating dairy manure in a liquid state by a tandem thermophilic-mesophilic aerobic stabilization process, more commonly described as liquid composting. Experimental apparatus were set up at an operating dairy. The study showed that the liquid composting process must successfully balance the opposing requirements of sufficient oxygen and minimum air flow. Surplus oxygen is required for maximum biological activity wheras the air flow must be minimized to preclude the need for an external heat source. Results with an oxygen-enriched air supply pointed out the potential advantages of a pure oxygen system. Microscopic investigation indicated a greater diversity in the mesophilic microorganism population than in the thermophilic population. This lack of diversity in the thermophilic population can help to explain the finding that the rate of stabilization of manure appeared to be limited at thermophilic temperature as it is at mesophilic temperatures. Cost estimates for a liquid composting process to serve 500 cows were developed within the context of costs for current dairy operations. Estimates showed that significant costs would be added to current dairy operations. Cost of liquid composting was compared with cost of conventional composting. This comparison revealed that the greater costs of liquid composting can be identified with greater capital investment of facilities and with greater energy requirements to bring oxygen, microorganisms, and substrate together. Such informatiion is important in considering whether costs of liquid composting could be borne by current dairy operations. (Montgomery-Consulting Engineers, Inc.; Merryman, ed.)

### 2729 - A1, B2, D4 200

### LIQUID COMPOSTING APPLIED TO AGRICULTURAL WASTES,

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A. R. Terwilleger and L. S. Crauer
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 501-505.

Descriptors: Liquid wastes, Equipment, Aerations.
Identifiers: Composting, Treatment efficiency.

Aeration of agricultural wastes at elevated temperatures is a treatment process with many advantageous features. The De Laval Separator Company is presently applying this process to dairy waste, swine waste, and confined beef feedlot waste in the United States. The process, the equipment, and the operational mode of the systems will be described as they treat waste products from actual field installations. The treatment efficiency of these field systems are described in terms of accepted parameters. Advantages cited for this process include a rapid degradation rate, significant solids reduction, reduced viscosity during aeration, significant coliform reductions, odor reduction, and flexibility to meet requirements of varied situations and desired treatment efficiency. (Terwilleger-DeLaval Separator Company)

### 2730 - A1, B2, D4 200

### INVESTIGATIONS ON THE PROCEDURE AND THE TURN-OVER OF ORGANIC MATTER BY HOT FERMENTATION OF LIQUID CATTLE MANURE,

Institut fur Bodenbiologie der Forschungsanstalt fur Landwirtschaft (FAL)
K. Grabbe, R. Thaer, and R. Ahlers
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 506-509.

Descriptors: Fermentation, Liquid wastes, Dairy industry, Organic wastes, Ammonia, Pathogens, Nitrogen, Chemical properties.
Identifiers: Turn-over.

Hot fermentation of liquid manure, caused by self-heating through aeration, took place in a tank with a diameter of 3.25 m, which was equipped with a so-called Fuchs-aerator, or other devices. Dry matter content was increased from near zero to 12 per cent. After intervals of some days, different amounts of fermented material were replaced by fresh manure. Data are given for the temperature course and the turn-over of the organic components. Loss of organic material, nitrogen, and total volume was measured. Balances of energy were made. During the process, ammonia was a source of odor. Its emission increased with temperature and was different with different equipment. Since higher temperatures stimulate the turn-over of organic matter, and trials with salmonellae and different parasites showed that a temperature of about 45 degrees C is necessary to kill the pathogenic agents, a combination of both processes was tested with success. The treated liquid manure's stability varied between two weeks and some months. Experiments in a laboratory fermentor were conducted with the goal of retaining nitrogen. In these studies, in which silage effluent and liquid dairy cattle manure were used, data were obtained on the formation of biomass, its composition, and its fate during the fermentation process and during storage. Distribution of nitrogen in different fractions such as lignin and humic acids was analyzed. Further data are given on investigation on the influence of temperature on pH changes, the problem of alkalinity caused by a resin effect of the organic material, and the possibilities of stabilizing highly concentrated biomass production according to the different aspects of its utilization. (Grabbe-Germany; Merryman, ed.)

### 2731 - B2, C5, D4 200

### OXIDATION DITCHES FOR LIVESTOCK WASTES,

Department of Agricultural Engineering, Illinois University, Urbana
D. L. Day, D. D. Jones, A. C. Dale and D. Simons
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 510-513.

Descriptors: Livestock, Aerobic treatment, Design criteria, Nutrients, Economics.
Identifiers: Oxidation ditches.

This is a state-of-the-art paper proposal on the design and development of oxidation ditches used for aerobic treatment of livestock wastes. The paper summarizes information from several publications that the authors have helped with, such as Illinois Agricultural Experiment Station Bulletin 737 "Aerobic Treatment of Livestock Wastes," the "Aerobic Treatment" chapter of the North Central Regional Publication 206, and the proposed recommendation for the ASAE yearbook "Oxidation ditches for Livestock Wastes." In addition, current practices are included that result from practical as well as research installations. The objective of this paper is to consolidate and summarize literature and recommendations on the use of oxidation ditches for aerobic treatment of livestock wastes beneath slotted floors in confinement livestock buildings. The paper covers such major topics as: (1) Purpose and scope, (2) Description and basic principles, (3) Design criteria, (4) Start-up, (5) Operation, (6) Bath discharge system versus continuous discharge system, (7) Nutritive value of aerobically treated mixed liquor, and (8) Economic and energetic considerations. Types of aerators, circulation patterns, and power efficiencies are discussed. An up-date of pertinent literature references is included covering projects and installations around the world. (Day, et. al.-Illinois, Indiana, and West Germany; Merryman, ed.)

### 2732 - B2, C5, D4 200
### NITROGEN TRANSFORMATIONS IN AERATED BEEF SLURRIES,

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R. O. Hegg and E. R. Allred
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 514-516.

Descriptors: Nitrogen compounds, Slurries, Aerobic treatment, Cattle.
Identifiers: Nitrogen transformations.

Laboratory and field studies were conducted to determine the changes in the organic nitrogen in aerated beef slurries under temperatures from 2 to 20 degrees C. Variables measured included pH, dissolved oxygen, organic-nitrogen, ammonium-nitrogen, nitrite-nitrogen, nitrate-nitrogen, total solids, nitrifying bacteria populations of Nitrosomonas and Nitrobacter, and the heterotrophic population. Three batch operated, laboratory experiments, one of 15 weeks duration and two of 20 weeks duration, were conducted in six, 20 liter containers, with duplicates at temperatures of 1.7, 7.2, and 12.8 degrees C under controlled aerated rates and constant mixing to prevent anaerobic zones. The field studies were conducted in a pilot-scale beef oxidation ditch that received waste from 36 animals over a 14 month period. The conclusions were (1) Laboratory, batch operated, continuously fed aerobic digesters produced nitrogen transformations similar to a pilot-scale oxidation ditch. (2) Nitrite-N and nitrate-N concentrations reached several hundred mg/l at temperatures from 2 to 20 degrees C. (3) Nitrifying populations were 1/100 the heterotrophic population. Liquid temperatures from 2 to 13 degrees C did not seem to affect the maximum bacteria population. (4) The nitrifying population appeared to be quite stable even under oxygen limiting conditions. (5) Overall nitrogen balances on the 15 to 20 week experiments resulted in 50-75 per cent nitrogen losses. (6) Nitrite buildups are not due to ammonia toxicity of Nitrobacter bacteria. (Hegg and Allred-Minnesota)

### 2733 - B2, C5, D4 200
### A DESIGN APPROACH FOR THE USE OF AN OXIDATION DITCH FOR LIVESTOCK WASTE TREATMENT,

Research Specialist, Department of Agricultural Engineering, Manitoba University, Winnipeg, Manitoba R3T 2N2
E. J. Kroeker and R. C. Loehr
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 517-521.

Descriptors: Design, Aerobic treatment, Livestock, Poultry, Model studies.
Identifiers: Oxidation ditch, Waste management.

Information is now available for the rational design procedure of the oxidation ditch based upon knowledge of waste characteristics, desired stabilization objectives, and biological waste treatment fundamentals. This paper presents: (1) the development of the design procedure, (2) results of the verification, (3) potential application to other livestock waste situations, and (4) the value of the approach as a management as well as design tool. A mathematical model was developed which includes relevant design and operating parameters for a continuous flow oxidation ditch treatment process. The model serves as a design and management tool for any of the following objectives: (1) odor control, (2) nitrogen removal, (3) nitrogen conservation. The model and resulting design procedure were applied to the design of an oxidation ditch for the treatment of caged-layer poultry wastes. Treatability data were used to establish empirical equations to calculate oxygen requirements, removal of nitrogen by nitrification-dentrification, and the removal of raw waste total solids. The model was verified by utilization of independent data from two large scale treatment systems. Model predicted design parameters were compared to actual operating parameters for two independent systems which are treating the wastes from 4,000 and 15,000 caged layers respectively. The verification indicated that the model could be used as a rational design procedure. In addition, several areas of needed research were identified. (Kroeker and Loehr-Manitoba and New York; Merryman, ed.)

### 2734 - C5, D4 200
### A THEORETICAL DESCRIPTION OF AEROBIC TREATMENT,

Department of Agricultural Engineering, The University of Newcastle upon Tyne, England
J. L. Woods and J. R. O'Callaghan
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 522-525.

Descriptors: Aerobic treatment, Poultry, Model studies, Chemical oxygen demand, Equations.
Identifiers: Swine, Monod theory.

The paper describes a mathematical interpretation of aerobic treatment results for pig and poultry manures. The analysis is based on a theory first postulated by Monod (1942) for single strain cultures and since applied extensively by microbiologists for single strain and mixed microbial populations. The Monod description has been used successfully for sewage and industrial wastes and this particularly recommends it to the animal waste treatment field. The model is applied to laboratory results for pig and poultry wastes. The main features of the resulting equation are: (i) The biological fraction of C.O.D. remaining in the output supernatant is inversely proportional to the micro-organism retention time. (ii) The biological fraction of C.O.D. remaining in the output supernatant is independent of the feed concentration. The micro-organism population adjusts to consume the substrate available. (iii) The treatment characteristics of poultry and pig waste are very similar. The prediction equation for C.O.D. is compared with field treatment plants currently operating in Britain. The agreement is good and these results form a basis for the extension of the model to describe solid and solate biodegradation simultaneously. However, it is important to check these results with the data of other workers for pig and poultry wastes and to extend them to other animal manures. (Woods & O'Callaghan-University of Newcastle upon Tyne; Merryman, ed.)

### 2735 - A5, B2, C5, D4, F1 200
### AN EVALUATION OF AERATION SYSTEMS FOR POULTRY WASTES UNDER COMMERCIAL CONDITIONS,

Research Specialist, Department of Agricultural Engineering, Cornell University, Ithaca, New York
J. H. Martin, Jr. and R. C. Loehr
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 526-529.

Descriptors: Biological treatment, Design criteria, Costs, Poultry.
Identifiers: Odor control, Oxidation ditch, Waste stabilization, Settling tanks.

Cornell Agricultural Waste Management Program is engaged in studying the viability of aerobic, biological treatment of poultry wastes for odor control and waste stabilization. The wastes from 8200 laying hens at Manorcrest Farms, Camillus, New York, are being treated with two oxidation ditches which differ with respect to levels of oxygen transfer. Aeration equipment was sized to meet the total oxygen demand of the wastes in one ditch and only a portion of the total oxygen demand in the other. The result is odor control and nitrogen management in one ditch and only odor control in the other. This study also includes separation of the residual solids following biological degradation by means of settling tanks. This permits low solids concentrations in the mixed liquor which improves oxygen transfer and concentrates solids prior to ultimate disposal. Specific objectives of the study are: (1) Evaluation of available design parameters for oxidation ditches treating poultry wastes, (2) Economic assessment of the process in terms of both capital and operating costs, (3) Identification of problem areas not recognized in smaller scale studies. The paper discusses the study results in terms of: (1) Oxygen requirements for management objectives such as odor control or odor control and nitrogen management. (2) Waste stabilization efficiency in terms of levels of oxygen input. (3) Oxidation ditch channel design which optimizes the aerators capacity of oxygen transfer and mixing. (4) Capital and operating costs in terms of total egg production costs. (5) Performance of the settling tanks in solids removal and concentration. The paper also includes suggested methods of management and alternatives for integrating the oxidation ditch into a total waste management system. (Martin and Loehr-Cornell University; Merryman, ed.)

### 2736 - A5, B2, C5, D4, F1 200
### TURBINE-AIR AERATION SYSTEM FOR POULTRY WASTES,

Research Leader, ARS, USDA, Agricultural Engineering Department, Cornell University, Ithaca, New York
A. G. Hashimoto and Y. R. Chen
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 530-534.

Descriptors: Poultry, Costs, Design criteria.
Identifiers: Turbine-Air Aeration, Odor control, Waste stabilization.

The successful application of aeration systems to control odors and stabilize wastes from livestock operations has been documented. Aeration systems are currently being used commercially and are also being actively investigated under experimental conditions. One of the most serious liabilities of available aeration systems is the relatively high operating costs associated with these systems. This study was undertaken to evaluate the Turbine-Air Aeration (TAA) system in terms of: oxygenation capacity, power requirements, operating costs, and feasibility of treating poultry wastes. Studies were conducted using tap water, and batch and continuous feeding of poultry manure. The TAA system consists of a 54 inch diameter by 10 foot deep tank, with four 4 inch baffles along the circumference parallel to the tank center axis. Two air diffusers are located at the tank bottom below an 18 inch diameter turbine. The major advantage of this system over mechanical (oxidation ditches, surface aerators) or pneumatic (diffused air) aeration systems is the flexibility to obtain optimum mixing and aeration simultaneously, which would result in a more efficient aeration system. Parameters necessary to design Turbine-Air Aeration systems are summarized and design procedures discussed. (Hashimoto and Chen-Cornell University; Merryman, ed.)

### 2737 - A1, B1, E2 200
### SLUDGE MANAGEMENT FOR ANAEROBIC DAIRY WASTE LAGOONS,

Department of Agricultural Engineering, Florida University, Gainesville
R. A. Nordstedt and L. B. Baldwin
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 535-536.

Descriptors: Sludge, Anaerobic lagoons, Dairy industry, Chemical properties, Nitrogen, Economics.
Identifiers: Land disposal, Ruminant wastes, Hydraulic removal, Application rates.

Sludge accumulation rate and sludge composition must be evaluated with respect to the effect on lagoon performance and to the problems associated with sludge removal and dispersal on land. An anaerobic lagoon system on an 800 cow commercial dairy has been receiving wastes for nearly five years. Sludge accumulation rate and sludge composition have been determined. After four and one-half years, dense sludge occupied approximately 28 per cent of the lagoon volume and lighter sludge occupied an additional 45 per cent of the volume. Total solids in the lagoon had increased to an average of 7.49 per cent. Chemical analysis of sludge samples indicates a significant accumulation of nitrogen in the anaerobic lagoon. Total nitrogen in the lagoon averaged 2550 mg/l, representing a total of 17000 kg of nitrogen. Approximately 82 per cent of the nitrogen was in the ammonium form. Other sludge characteristics have also been determined and are discussed relative to the effects of dispersal of the sludge on cropland. Sludge consistency is such that it may be removed hydraulically, using commercially available pumps and other equipment. Scheduling and rate of removal from the lagoon make the use of contract dredging services uneconomical in most cases. A pilot scale sludge removal operation, carried out at the lagoon under study, is discussed; including rates of application on land, effects on soil, and replanting procedures. (Nordstedt and Baldwin-Florida University)

### 2738 - B2, C3, D4, E2 200

## TRENDS AND VARIATIONS IN AN ANAEROBIC LAGOON WITH RECYCLING,

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C. V. Booram, T. E. Hazen, and R. J. Smith
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 537-540.

Descriptors: Lagoons, Anaerobic conditions, Recycling, Chemical properties, Sludge, Water quality.
Identifiers: Swine, Land disposal.

Changes that have occurred in water quality of an anaerobic lagoon during nine years of recycling at the Swine Nutrition Research Station, Iowa State University, Ames, Iowa are described. Constructed and placed into operation in 1962, water quality data on this lagoon were first collected in 1964, shortly after recycling was begun. Since that time data have been collected for the years 1966 and 1968 through 1973. The basic water quality parameters of COD, ammonia nitrogen, kjeldahl nitrogen, chlorides, phosphorus and pH are summarized. Data analysis indicates that ammonia nitrogen, kjeldhal nitrogen, chlorides and COD are increasing with respect to time. Phosphorus concentration has remained relatively constant and pH is gradually decreasing with time. The data collected provide an insight into lagoon water quality changes under a management system of recycling with spray irrigation disposal of the excess. Inferences and an estimation of possible effects of continued recycling are presented. The nutrient content of the sludge in the anaerobic lagoon are presented. Accumulation of sludge is pertinent to treatment system longevity. The lagoon stores and treats the waste products from a 700 head swine confinement building. Since construction in 1962, the lagoon has been sampled 3 times to observe sludge accumulations. The sludge contained 72 per cent of the nitrogen, 69 per cent of the phosphorus and 92 per cent of the organic matter in the lagoon contents. Sludge accumulation occupied 19 per cent of the lagoon volume in 1966 and 30 per cent in 1973. The slower rate of increase in sludge content since 1966 is partly due to biological stabilization during the first few years following construction, and partly because of some solids removal along with liquid withdrawl. Prior to 1968, the lagoon was periodically discharged to storage ponds. Since then the level has been controlled by irrigation onto adjacent land. With proper design initially and reasonable management thereafter, these data indicate that an anaerobic lagoon for swine wastes should not rapidly fill with accumulated solids. (Booram, et. al.-Georgia University, etc.; Merryman, ed.)

### 2739 - A1, B2, C3, D4, E1 200

## A LAGOON-GRASS TERRACE SYSTEM TO TREAT SWINE WASTE,

Professor of Agricultural Engineering, Missouri-Columbia University, Columbia, Missouri
D. M. Sievers, G. B. Garner and E. E. Pickett
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 541-543.

Descriptors: Waste treatment, Anaerobic lagoons, Performance, Effluent.
Identifiers: Lagoon-grass terrace system, Swine, Chemical build-up.

The waste management system for a swine finishing unit (300 hd) was studied to determine its treatment effectiveness and to assess the system's effect on a nearby municipal water supply reservoir. The system consisted of a slotted floor over an anaerobic lagoon and an 850 ft. grassed terrace. During precipitation events, the lagoon discharged to the terrace where renovation and dilution of the effluent occurred. Leaving the terrace, the liquid flowed an additional 800 ft. and entered the small arm of a municipal water supply reservoir. The anaerobic lagoon was malfunctioning biologically due to chemical build-up. Attempts were made to improve biological activity in the lagoon by pumping the liquid fraction and diluting the sludge with fresh water. Samples of the lagoon effluent and flow in the terrace were analyzed for 14 chemical and physical parameters during a 0.9 inch precipitation event. Over 80 per cent reductions in the concentrations of total and volatile solids, Zn and Cu, and over 90 per cent reductions in COD, BOD$_5$, TKN, total P, Na and K were achieved in the terrace. Soil samples (to 4 ft. taken along the terrace channel indicated that most chemicals held by the soil were largely removed in the first 200 ft. of terrace . . . Controlled discharge of the lagoon coupled with the grassed terrace proved effective in protecting the reservoir from pollution. Annual pumping of the lagoon liquid and dilution of the sludge with pond water produced an average reduction of 30 per cent of all measured parameters and resulted in improved biological activity. However, chemical concentrations built up within one year to higher levels, suggesting that the sludge must be removed to maintain a non-toxic environment in the lagoon. (Sievers, Garner, & Pickett, Missouri University; Merryman, ed.)

### 2740 - B1, D4 200

## BIOENGINEERING ASPECTS OF ANAEROBIC DIGESTION OF PIGGERY WASTES,

Scottish Farm Buildings Investigation Unit, Craibstone, Bucksburn, Aberdeen, Scotland
A. M. Robertson, G. A. Burnett, P. N. Hobson, S. Bousfield, and R. Summers
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 544-548.

Descriptors: Anaerobic Digestion, Energy, Methane, Equipment, Design, Sludge.
Identifiers: Swine, Scotland.

Anaerobic digestion is a method of reducing pollutional load of strong farm wastes which may also provide usable energy as methane. Laboratory studies were used as the basis for design and operation of a small farm scale plant to treat waste from an intensive piggery. Trials with 15 litre and 100 litre continuous digesters showed methods of start-up, operation and minimum turnover times in relation to waste purification and gas production to be expected in large scale digesters. The farm scale plant was designed to give low maintenance, efficient continuous digester of defined performance. The plant consists of a 13,000 litre digester with feed and overflow tanks, feed pump and gas holder. Temperature control (at 35 degrees C) is provided by circulating the digester contents through an external heat exchanger heated by a digester-gas boiler or a stand-by oil fired boiler. After initial seeding with domestic digester sludge, loading of piggery wastes was gradually increased to 450 litre-day at approximately 4 per cent TS and eventually a retention time of 10 days with waste containing higher solids concentrations should be achieved. During the first six months of running, results showed that a stable digestion had been attained; reductions in pollutional load of the whole unsettled waste were on average BOD 91 per cent, TS, 40 per cent, VFA 92 per cent, COD 30 per cent with ammonia generally unchanged. Stirring by heat exchanger flow proved inadequate over long periods; an impermeable crust developed which reformed after breaking. Other methods of stirring are being investigated; at present a twin-disc, slow speed turbine is being tested for optimum speed and time of intermittent stirring. An input of uniform solids concentration is desirable and is provided by a stirrer in the 1000 litre feed tank working for a few minutes before and during operation of the input pump. Digester loading has been stopped with and without heating for days or weeks during over 12 months experimentation. Digestion has always returned to normal soon after loading restarts. Ingress of small amounts of air does not retard digestion but nitrogen appears in the gas. Leakage of large amounts of air eventually stopped digestion; oxygen appeared in the gas but before this nitrogen dilution had stopped gas combustion. Gas production has been equal to or better than the pilot plant values and at 65-70 per cent $CH_4$ gas burns readily to provide a heat source for the digester. At full loading surplus gas should be available for other uses. (Robinson, et. al.-Scotland; Merryman, ed.)

### 2741 - A1, B2, D4 200

## SIMULATION OF FUNDAMENTAL ANAEROBIC LAGOON KINETICS,

Department of Agricultural Engineering, Clemson University, Clemson, South Carolina
D. T. Hill and C. N. Barth
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1974, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 549-552.

Descriptors: Model studies, Mathematical models, Computer models, Anaerobic lagoons, Performance, South Carolina.
Identifiers: Swine, Loading rates.

Laboratory scale models, mathematical modeling, and computer simulation are used to predict the performance of anaerobic lagoons treating swine waste at 10 degrees C and 25 degrees C at varying loading rates. The laboratory units consist of a simple plexiglas reactor placed in environmental chambers simulating typical winter and summer conditions for South Carolina. Feeding rates for each run (at 10 degrees C and 25 degrees C) ranged from .5 to 64 lbs V.S./1000 ft$^3$ -Day. Theoretical detention time for both runs was 200 days. Performance is judged on the basis of volatile matter (V.M) reduction and volatile organic acid (VOA) concentration. The mathematical model interfaces chemical reactor theory with a stoichiometric model of the chemistry of swine waste and a kinetic model of microbial growth. The stoichiometric model provides the basis of conversion of swine waste to soluble organics, VOA, and ultimately to methane and carbon dioxide. The theoretical yields obtained from the stoichiometry are then integrated into a kinetic model of microbial growth and substrate utilization. Inhibition by high organic acid concentration, which occurred throughout the study is incorporated into the mathematical model as well as suppression of the growth and substrate utilization kinetics by an Arrhenius type temperature relationship. The mathematical model assumes that two distinctly different microbial groups are active: 1) acid formers (falcultative heterotrophes) and 2) methane formers (obligate anaerobes). Metabolic and environmental requirements of these two groups are significantly different. Accounting for these differences in the simulation necessitates the use of the two-microbial-culture model . . . The results of the two runs indicate that the conventional techniques used to simulate rapid treatment processes such as activated sludge or trickling filters may not be adequate to model lightly loaded-long detention time biological processes. (Hill & Barth-Clemson University; Merryman, ed.)

### 2742 - A1, B2, D4, E2 200

### AEROBIC TREATMENT OF PIGGERY WASTE PRIOR TO LAND TREATMENT-A CASE STUDY,

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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 556-559.

Descriptors: Aerobic treatment, Slurries, Odor, Water pollution.
Identifiers: Swine, Land disposal, Spraying, Scotland.

The investigation was carried out on a 100 ha farm situated at the top of a water catchment area. 5,000-6,000 fattening pigs, fed on a diet of whey supplemented by barley meal and other fibrous and carbohydrate material, where housed there. About 80 m$^3$ of excreta (12-20 g/l $BOD_5$, 20 g/l TSS) drained daily from the piggeries into a 380 m$^3$ slurry tank. This slurry was sprayed onto the land using rain-guns at a rate of 36m$^3$/h. At the start of the investigation both odor and stream pollution caused considerable concern. Chemical and bacteriological examinations of the drainage water, in open ditches surrounding the farm were carried out. Most pollutants gained access to these ditches during the time of spraying slurry onto adjacent fields. However, there was sufficient residual material remaining on the land, to be washed out following rainfall, and encourage slime growth in the ditches. A 10 kW floating surface aerator was installed on the slurry tank to evaluate the use of partial aerobic treatment. Loading rate to this system was 0.15 g $BOD_5$/g MLTSS.d. Mean residence time varied between 4 and 5 days due to spraying operations. Odor was eliminated from the tank and greatly reduced during spraying. Contamination of the water in the ditches adjacent to the sprayed fields with faecal bacteria and organic matter was reduced (maximum $BOD_5$-380 mg/l prior to treatment, 130 mg/l after treatment. To overcome the problems of oxygen limitation and variable loading rate, another 400 m$^3$ tank equipped with three 5 kW fixed surface aerators has been installed. The existing tank and 10 kW floating aerator are used as a combined secondary treatment unit and balancing tank. Continuous monitoring equipment for effluent flow into the main tank and dissolved oxygen, pH and temperature within the tank have been installed. Routine analyses of the mixed liquors and drainage waters are being carried out during the initial operation of this new plant. The two stage system should further reduce organic pollutants without an increase in nitrate concentration and consequent possibility of eutrophication. (Evans-Scotland)

### 2743 - B1, D4 200

### BIOLOGICALLY-CONTROLLED LOADING OF AEROBIC STABILIZATION PLANTS,

Bacteriology Division, School of Agriculture, Aberdeen, Scotland.
K. Robinson and D. Fenlon
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 560-563.

Descriptors: Design criteria, Variability, pH, Fermentation.
Identifiers: Aerobic stabilization plants, Loading rates, Scotland.

Although use of mean values for the BOD, COD, total volume and solids content of raw animal wastes may be acceptable as initial design parameters for aerobic stabilization plants, it is important to remember that in commercial conditions their day-to-day values may vary considerably as a result of changes in stocking density, feed quality and quantity, and a variety of other factors. These factors plus changes in environmental conditions such as pH, dissolved oxygen and temperature make it difficult to achieve steady-state conditions. Even an approximation to steady-state cannot be expected unless allowance is also made during operation for the variable response of the treatment microflora to uncontrolled environmental factors. It was considered that a system of loading responding directly to metabolic activity would permit more efficient operation and ultimately lead to the development and use of an automated farm waste stabilization plant. Feasibility of pH as a loading-control parameter has been studied with the aid of a continuous laboratory fermenter. The fermenter was operated on the basis of a volume of raw waste (supernatant liquor from an anaerobic lagoon for the storage and anaerobic digestion of swine waste) displacing an equal volume of mixed liquor from the treatment vessel. Quantity and frequency of addition were dependent on pH of the mixed liquor and were controlled with the aid of a pH meter controller. Operation of the fermenters at pH values in the range 6.0-8.0 has been examined and compared. The results have shown the ability of the method to control loading rates at retention times of 2-20 days, to prevent large variations in the pH and dissolved oxygen content of the mixed liquor, to produce a stabilized end-product of uniform composition and to virtually eliminate the need for frequent analysis of raw waste quality. Developments are now in hand to test the feasibility of the method under field conditions. (Robinson-Scotland; Merryman, ed.)

### 2744 - A1, B1, D2, D4, E3 200

### PERFORMANCE OF AN AUTOMATED WASTE TREATMENT AND RECYCLE SYSTEM,

Department of Agricultural Engineering, Ohio State University, Columbus 43210
E. P. Taiganides and R. K. White
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 564-567.

Descriptors: Waste treatment, Recycling, Swine, Design, Performance, Effluent, Aeration, Research and development, Feasibility studies.
Identifiers: Oxidation ditch, Settling, Clarification.

A treatment plant consisting of primary settling (stationary screen), aeration (oxidation ditch) and final clarification (settling tank) was constructed in 1971 to receive from a swine confinement unit wastes being flushed out hydraulically. The treated effluent was recycled for flushing liquid. Values used in the design of each component of the system were presented at the 1971 ISLW and were published in the Proceedings of that Symposium. The total system was monitored for 3 full years (June, 1971-May, 1974) with weekly samples and daily supervision. The average monthly BOD removal efficiency of the plant ranged from a minimum of 65 per cent in winter months to a maximum of 88 per cent in summer months with the annual mean being 78 per cent. COD removal ranged from 51 per cent to 76 per cent. Effluent BOD was less than 80 mg/1 50 per cent of the time during the period April through October and less than 140 mg/l for half of the time for the 3-year testing period. Effluent BOD's as low as 24 mg/l were reached during summer periods. Influent BOD averaged 1400mg/l. Average monthly removal efficiencies for other parameters were 67 per cent for COD (51-76 per cent), 82 per cent for TSS (42-94 per cent), 57 per cent for TVS (44-64 per cent), and 43 per cent for maintenance and repair requirements of each of the system components were also monitored and the results will be reported. The purpose of the plant was to demonstrate the technical and environmental feasibility of an automated system of waste removal, collection, treatment and recycle without creating pollution or public nuisance. The plant performance met fully the objectives of the demonstration project. The system can now be considered for marketing. (Taiganides-Ohio State University)

### 2745 - A5, B2, C5, D4, E2 200

### SURFACE AERATION: DESIGN AND PERFORMANCE FOR LAGOONS,

Biological and Agricultural Engineering, North Carolina State University, Raleigh
F. J. Humenik, M. R. Overcash, and T. Miller
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 568-571.

Descriptors: Aeration, Design, Performance, Lagoons, Costs, Effluent.
Identifiers: Swine, Land disposal.

Several pilot and production scale surface aerators both fixed and floating, were investigated to elucidate mechanisms for organic and nitrogen removal as a pretreatment prior to effluent land application. Potential for odor control and nitrification-denitrification were evaluated. In a pilot scale unit (600 ft$^3$) with a variable speed surface aerator, it was found that the two conflicting mechanisms were occurring simultaneously, i.e.: (1) improved stabilization and volatilization, and (2) the restriction of effective settling removal and sludge resuspension. The use of surface area, lagoon volume, aerator horsepower, and anti-erosion plates are discussed as these relate to design and actual field operation. In units operating at 6000 ft$^3$-h.p. and 3750 ft$^3$-h.p. of aeration the supernatant nitrogen levels were both 1200-1400 mg/l with a loading rate of 40 ft$^3$ of lagoon volume-100 lb hog. Sludge depths were 30 inches and 9 inches respectively. Gas evolution was about .11 ft$^3$/day-ft$^2$ of surface area, and gas composition as well as potential of a nitrification-denitrification sequence are discussed. The field scale floating aeration basin is the first stage of pre-treatment for a large swine breeder operation and contains 1 h.p. of aeration per 6,000 ft$^3$ of lagoon (1 h.p. per 1350 ft$^2$ of area). The supernatant nitrogen, phosphorus and organic carbon concentrations are given as well as rates and quantity of sludge accumulation. Actual amount of odor control in surface aeration systems is discussed with consideration of the increased volatilization and the aerobic stabilization of odorous components in the surface aerobic zone and effect on lower anaerobic area. Estimated cost factors for aeration and the overall purpose of such surface aeration basins in a total waste treatment system are discussed. (Humenik-North Carolina State University)

### 2746 - B2, C3, D1 200

### TREATMENT OF LIVESTOCK WASTES BY BARRIERED LANDSCAPE WATER RENOVATION SYSTEM,

Department of Agricultural Engineering, Delaware University, Newark
W. F. Ritter, and R. P. Eastburn
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 572-575.

Descriptors: Waste treatment, Dairy industry, Design criteria, Soils, Phosphorus.
Identifiers: Barriered Landscape Water Renovation System, Mid-Atlantic Region.

Data of laboratory and field studies on barriered landscape water renovation systems to treat dairy cattle wastes are presented. The main objectives of the research are to evaluate the barriered landscape water renovation system to treat dairy cattle wastes in the Mid-Atlantic States and to develop design criteria for barriered landscape water renovation systems for the Mid-Atlantic region. A laboratory study was conducted to evaluate soil types and depth of soil through which livestock wastes percolate for a barriered landscape water renovation system. Laboratory experiments were also conducted to evaluate the changes in levels of dilute acid soluble phosphorus. Data are presented for a 900 $ft^2$ barriered landscape water renovation system operated over a 9 month period. The data include COD, nitrogen, and phosphorus removal rates for the 9 month period. (Ritter-Delaware University; Merryman, ed.)

## 2747 - D2 200

## TERTIARY TREATMENT OF ANIMAL WASTEWATERS BY REVERSE OSMOSIS MEMBRANES,

Department of Agricultural Engineering, Ohio State University, Columbus
B. S. Mehta and E. P. Taiganides
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 576-579.

Descriptors: Tertiary treatment, Waste water treatment, Reverse osmosis, Animal wastes.
Identifiers: Membrane separation system.

Membrane systems have been employed to produce high quality potable water from saline waters and from a variety of supply sources. However, they have not been applied to purification of animal wastewaters. The purpose of this study was to test the efficiency of membrane separation system for the clarification of biologically treated animal wastewaters. An experimental apparatus was developed. The main components of the apparatus were the membrane module, high pressure pump, and appurtances for recording and collecting samples. Samples tested were taken from effluents of an anaerobic lagoon, an aerobic pond, and from the Automated Waste Treatment and Recycle Plant in Botkins, Ohio. Efficiency of removal was determined by changes in the concentration of the following parameters: TS, TSS, TDS, BOD, COD, nitrogen, phosphorus, conductivity, pH, color and turbidity. Removal efficiencies were measured at 5 levels of operating pressure, at 5 various influent temperatures, and at 5 different flow rates. Operational efficiencies were also evaluated and an estimate was made of the cost of tertiary treatment of biologically treated wastewaters. Color and turbidity removal was so high as to make the effluent look potable. Removal efficiencies achieved in other parameters were above 90 per cent. (Metha-Ohio State University)

## 2748 - A1, C1, E2 200

## PRESENT KNOWLEDGE ON THE EFFECTS OF LAND APPLICATION OF ANIMAL WASTE,

Department of Agronomy, Kansas State University, Manhattan
G. W. Wallingford, W. L. Powers, and L. S. Murphy
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 580-582.

Descriptors: Animal wastes, Soils, Physical properties, Chemical properties.
Identifiers: Literature review, Land disposal, Loading rates.

The purpose of this research was to review the literature and analyze research needs on the effects of land disposal of animal waste. A secondary objective was to assemble published information on application guidelines for animal waste. Included is information on characteristics of the waste, effects of waste on soil and water near the application site, loading rates, application techniques and research needs. Waste characterization data in the literature were compiled by recording all usable data and classifying them by climatic region, species (animal), and type (liquid or solid) of waste. The variability in composition within a climatic region, species and type of waste was so great that no general characterization could be made within each classification. Factors affecting the composition of the waste are discussed. Effect of land disposal on the physical, chemical and biological properties of the soil are discussed as well as its effect on groundwater quality below the disposal site, runoff quality from the disposal site, and plant growth on the disposal site. A discussion on the benefits of animal waste disposal as well as the hazards of animal waste disposal on land is given. Existing literature is discussed with the ultimate objective in mind of developing application guidelines for animal waste disposal. Where insufficient literature exists to develop these guidelines, research needs are discussed. (Wallingford-Minnesota University; Merryman, ed.)

## 2749 - A1, E2 200

## COMPARISON OF LINT COTTON FIELDS FOLLOWING APPLICATIONS OF BEEF CATTLE WASTES AND COMMERCIAL NITROGEN,

Delta Branch, Mississippi Agricultural and Forestry Experiment Station, Stoneville
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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 583-586.

Descriptors: Cattle, Cotton, Yields, Liquid wastes, Solid wastes, Soils.
Identifiers: Land application, Application rates.

The objectives of the research were to: compare liquid vs. solid manure from beef feedlots for cotton production; compare injections of liquid manure to surface application; and evaluate cotton yield response to various manure application rates on two soil types. Lint cotton yields following application of 40, 80, 120, and 160 lb/ac of commercial nitrogen were compared with 4, 8, 12, and 16 tons/ac of solid and liquid manure on a Dubbs silt loam soil in 1972. Liquid or solid manure applied at a rate of 16 tons/ac or 120 lb of N/ac resulted in lint cotton yields of 926, 965, and 944 lb/ac, respectively. Injection of 24 tons/ac of liquid manure in 1972 and 24 and 36 tons/ac in 1973 into Dubbs silt loam soil resulted in yields of 1141, 1036, and 1141 lb lint cotton per acre, respectively. These yields were greater than yields of 981, 883, and 987 lb/ac following comparable rates applied to the surface of the soil. Liquid manure injected into the soil at 24 tons/ac of liquid manure in 1972 and 24 and 36 tons/ac in 1973 resulted in lint cotton yields similar to those obtained following 120 lb of N/ac (1089 vs. 1135 and 1141 vs. 1178 lb/ac, respectively). During 1973, 18, 24, 30, and 36 tons-ac were applied across 0, 50, and 100 lb N/ac on a Dubbs silt loam soil. Lint cotton yields for manure rates were 1120, 1182, 1187, and 1116 lb/ac, respectively. Across all rates of liquid manure, application of the zero level of N resulted in lower lint cotton yields when compared to 100 lb of N/ac. There was no interaction between rate of manure and rate of N applied. Peak lint cotton yields occurred in the range of 24 to 30 tons/ac of liquid manure. Liquid manure was injected into Sharkey clay soils at rates of 24, 36, and 48 tons/ac in 1973 and compared to 120 lb of N/ac. Lint cotton yields were 683, 725, 761, and 761 lb/ac, respectively. (Spurgeon-Mississippi; Merryman, ed.)

## 2750 - A1, E2 200

## ON-THE-FARM DETERMINATION OF ANIMAL WASTE DISPOSAL RATES FOR CROP PRODUCTION,

Professor of Soil Science, Washington State University
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Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 587-590.

Descriptors: Waste disposal, Pacific Northwest U.S., Crop response, Denitrification, Leaching, Equations, Dairy industry.
Identifiers: Waste management, Disposal rates.

Livestock operators in the Pacific Northwest need a means whereby they can estimate waste loading capabilities of their soils. Seventy per cent of the 300,000 dairy cows in Washington and Oregon are west of the Cascade mountains in areas having heavy winter rainfall. Waste disposal poses pollution problems which are especially troublesome when alluvial soils are saturated. Waste handling and transport systems in conjunction with field applications are under study at three dairy locations; cattle populations range from 130 to 350 head. Two installations receive 40 to 60 inches annual precipitation; one gets 20 inches annual rainfall. Detention ponds for winter storage and pumppipe distribution systems are used at all locations. A soil injection system is also used at one site. Tile drainage effluent from beneath lagoons is being monitored for $NO_3$-N and coliform bacteria at one location. Data indicate the effluent to have less pollution than does the stream into which discharge occurs. Waste loading rates are being defined at all locations under field conditions. Crop removal of nitrogen is being measured with silage corn, cereal rye, and forage grasses. Nitrate-nitrogen concentrations in the forage are being determined as are $NO_3$-N concentrations in the soil profile to a 4-foot depth. Results indicate large amounts of animal manure can be applied to soils in the Northwest without accumulation of toxic $NO_3$-N in animal feed. A large amount of nitrogen is being denitrified. Soil nitrate leaching is minimal in the operations. These data are being used as a base to develop equations to estimate: (1) Manure nitrogen to provide for optimum crop yields without excessive nitrogen losses from volatization, denitrification, or leaching; and (2) Amount of residual manure nitrogen remaining for following years. (Turner-Washington State University; Merryman, ed )

## 2751 - A1, E2 200

## DISPOSAL OF DAIRY CATTLE MANURE ON SOIL,

Soil and Water Research, USDA, ARS, Auburn University, Auburn, Alabama
Z. F. Lund, F. L. Long, B. D. Doss, and F. E. Lowry
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 591-593.

Descriptors: Dairy industry, Cattle, Soils, Crop response, Forages, Agricultural runoff.
Identifiers: Land disposal.

Application of dairy manure to soil is an economical means of disposal, but high application rates may cause problems with quality of runoff water and forage. Dairy cattle manure was incorporated into the surface 15 cm of a Norfolk sandy loam and cropped with millet (Pennisetum americanum (L.) K. Schum) and rye (Secale cereale). Applications of 45 mt/ha/yr for 3 years resulted in BOD values of runoff water that did not exceed those for nonmanured plots. The nitrate-nitrogen content of runoff water was essentially unaffected by the manure treatment; the maximum did not exceed 3.7 mg/liter and averaged less than 2 mg/liter. Total N lost in runoff water averaged less than 3 kg/ha/yr. The same cropping system was used on plots of Dothan loamy sand, Lucedale sandy loam, and Decatur clay loam. Plots received 22.5, 45, 90, 180, and 270 mt/ha/yr of manure on a dry weight basis. The check plot received N, P, and K fertilizers totalling 450, 220, 450 kg/ha. The 180- and 270-ton manure rates caused plant injury the first year on both sandy soils. Millet yields were higher on the 45- and 90-mt-ha rates than on the check plots 2 out of 3 years. Both millet and rye forage produced on 180- and 270-mt/ha treatments had K-(Ca+Mb) ratios and nitrate levels that were potentially hazardous to animal health. Coastal bermudagrass (Cynodon dactylon (L.) Pers.) on Dothan and Lucedale soils received rates of 45 and 90 mt/ha/yr of solid manure and 45, 90, and 135 mt/ha/yr of liquid manure. Four applications of N, P, and K fertilizers were made to the check plots annually for a total of 470, 225, and 470 kg/ha. The mineral fertilizer plots yielded more forage the first year on the Dothan soil, and the second and third years on the Lucedale soils, than any manure treatment except the 90 and 135 mt/ha of liquid. Nitrate nitrogen in the forage was highly correlated with organic nitrogen in the plant tissue. Manure could be applied at the 45 mg/ha rate, either incorporated or on a Coastal bermudagrass sod, and produce nontoxic forage. (Lund-Auburn University)

### 2752 - A1, E2 200

### FERTILIZER VALUE OF LIVESTOCK WASTES,

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H. Tunny
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 594-597.

Descriptors: Fertilizers, Livestock, Nutrients, Performance, Slurries, Solid wastes, Silages, Nitrogen, Phosphorus, Potassium.
Identifiers: Application rates.

Results of experiments on nutrient composition of animal manures and the efficient use of these nutrients for grass production are presented. The first experiment deals with the variation in N, P, K and dry matter composition of manures from 70 cattle, pig and poultry farms. Manure stored as slurry had a wider variation between farms than manure stored as solid. Pig slurry showed the widest variation between farms; dry matter ranged between 1 and 21 per cent and nutrients also showed a wide variation. The other manure samples showed approximately a two-fold variation between highest and lowest farms. Results of the second experiment compared chemical fertilizer with cattle slurry and pig slurry as a source of nutrients for grass silage in 1973 and 1974. Nutrient levels applied, yields and results of plant and soil analysis are presented and discussed. Nitrogen in cattle slurry was approximately half and nitrogen in pig slurry two-thirds as effective as nitrogen in chemical fertilizers. Cattle slurry with adequate nitrogen supplied excess potassium and inadequate phosphorus; whereas, pig slurry supplied inadequate potassium and excess phosphorus. The silage from the three treatments was fed to three groups of animals. Feed intake and liveweight gain were recorded as an index of palatability, and silage quality. There was no significant difference in animal performance. In addition, a third experiment studied the effect of time of application and response of different grass species to animal manure. Preliminary results suggest that time of slurry application relative to time of cutting influenced grass production. (Tunney-Ireland; Merryman, ed.)

### 2753 - A1, E2 200

### PLANT AND SOIL EFFECTS OF SWINE LAGOON EFFLUENT APPLIED TO COASTAL BERMUDAGRASS,

North Carolina State University, Raleigh
G. A. Cummings, J. C. Burns, R. E. Sneed, M. R. Overcash, and F. J. Humenik
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 598-601.

Descriptors: Coastal Bermudagrass, Sprinkler irrigation, Design, Crop response, Agricultural runoff.
Identifiers: Swine, Land application, Lagoon effluent, disposal, Application rates.

Design, installation and operation of a completely automated permanent sprinkler irrigation system for land application of swine lagoon effluent on coastal bermuda grass is described. This system utilizes part-circle impact sprinklers located on the 4 corners of each 30 x 30 foot plot. The system is controlled by an electrically-operated turf-type controller, and water flow to individual sprinklers is controlled by thermal hydraulic remote solonoid values. During the first year of effluent application (1973) losses from runoff were negligible for P and low for all other constituents measured. With annual N application rates of 264, 527 and 1055 pounds per acre losses were 4, 9, and 17 lbs per acre with approximately the same K rate of application losses were 9, 17, and 38 pounds per acre. Per cent loss from runoff of Ca, Mg and Na were approximately the same as the per cent loss of N. Crop recovery of P, Ca, Mg and Na was much lower than recovery of N and K. Effluent application did not have a detrimental influence upon the forage in 1973 nor through August in 1974. Yields in 1973 were approximately 5, 6.5 and 7 tons of dry matter per acre as effluent application rates were increased. Nutrient balance sheets incorporating data from crop yield and analysis, runoff losses, soil analysis, and effluent application rates are presented. (Cummings-North Carolina State University; Merryman, ed.)

### 2754 - A1, E2, F1 200

### POLLUTION ABATEMENT OF POULTRY MANURE BY MAXI-MIXING METHOD,

Animal Science Department, Connecticut University, Storrs
W. A. Aho, G. F. Griffin, and A. K. Bakir
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 602-605.

Descriptors: Poultry, Costs, Waste disposal, Sampling, Nitrates, Nutrients, Anaerobic conditions, Pollution abatement.
Identifiers: Maxi-mixing, Composting.

Maxi-mixing is a term coined to describe a manure disposal system using a maximum amount of manure and a minimum amount of soil in a composting situation. Manure is returned to the soil system in massive quantities at low cost. Actual mixing is accomplished with a bulldozer or a payloader, folding manure and soil and windrowing. Odors are quelled almost immediately and under ideal temperature and aeration, composting occurs in several weeks. In November of 1970, 3,675 tons of poultry manure (59 tons nitrogen) was mixed in an area less than 2 acres. The area was too small to provide enough soil for a windrowed compost. The manure remained below ground level in a wet anaerobic state. The area surrounding this mass was sampled for nitrate and ammonia movement in 1971 and 1972. A brook flowing adjacent to the mix was monitored in 9 locations; 12 holes were also drilled to obtain ground water samples, and the farm well was sampled. No appreciable amounts of nitrates were found. The mix lay fallow from November, 1970 until April, 1974, when the site was required for disposal of another 6,300 tons of poultry manure. The site was appraised and soil samples and analyses were made. The analyses of soil three years following massive manure mixtures indicated high pH values (8.1 to 8.2) in manure residual zones and relatively high soluble salts (83 to 90 mhos x $10^{-5}$), very high ammonium levels (400 ug N-g soil) and very high levels of extractable calcium, phosphorus and potassium. Only a trace of nitrite was found in the samples. After the second maxi-mix water samples were taken from the adjacent brook and the farm well, neither showed pollution from the maxi-mix. Cost of maxi-mixing was 62 cents a ton in 1970 and 60 cents a ton in 1974. (Aho-Connecticut University; Merryman, ed.)

### 2755 - A1, B2, E2, F1 200

### ON LAND DISPOSAL OF LIQUID ORGANIC WASTES THROUGH CONTINUOUS SUBSURFACE INJECTION,

Department of Agricultural Engineering, Colorado State University, Ft. Collins
J. L. Smith, D. B. McWhorter, and R. C. Ward
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, 1975, p. 606-610.

Descriptors: Liquid wastes, Design, Costs, Dairy industry, Labor, Colorado.
Identifiers: Land disposal, Subsurface injection, Application rates.

Design, development, and utilization of a continuous liquid manure subsurface injection system are discussed. With the system, liquid manure is pumped from a holding tank or lagoon to a disposal field through rigid pipe. A 660 foot flexible hose is used to connect the pipeline to the mobile injector. The manure is injected at depths of 4 to 6 inches below the soil surface and mixed with soil thus minimizing the possibility for aesthetic pollution. The injector can be operated with a medium sized agricultural tractor. Disposal capacity ranges from 400 to 800 gpm of 5 per cent solid slurry depending upon the size of the equipment. A skilled operator can achieve application rates in excess of 50,000 gallons per acre per pass. The system is particularly adapted for use near population centers. The system is presented as an economically and environmentally sound alternative to current practices. Measurements of ground and surface water contamination are reported from on-going research where the system is being used on a dairy in Northern Colorado. The system offers significant savings in labor while improving the aesthetics of animal waste management. Operating costs are competitive with present systems. (Smith-Colorado State University)

### 2756 - A1, E2 200

### SOIL PROPERTIES AND FUTURE CROP PRODUCTION AS AFFECTED BY MAXIMUM RATES OF DAIRY MANURE,

Minnesota University, Southern Experiment Station, Waseca
G. W. Randall, R. H. Anderson and P. R. Goodrich
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 611-613.

Descriptors: Dairy industry, Chemical properties, Nutrients.
Identifiers: Land disposal, Application rates, Noncrop areas, Pollution potential.

Conditions sometime exist in livestock operations where acreage, time and/or labor may not be sufficient to allow manure application to land just prior to crop planting or at conventional rates. An experiment was established to determine the maximum amount of manure that can be applied and incorporated in a limited non-crop area. During 1971, 1972, and 1973, dairy manure was applied to the surface of a Webster clay loam soil. Manure was applied to the same 0.5-acre area in both 1971 and 1972. In 1973 this area was split and manure was applied to one of the 0.25 acre areas. In 1973 corn was planted on the other 0.25-acre area and on an adjacent border area that had received 32.7 T DM/A in 1970 and had been fallowed since. Manure application rates have totaled 103, 95.7 and 144.8 T-A (dry matter basis) for 1971, 1972 and 1973, respectively. Nutrient application rates over the 3-year period have totaled 20,150 lbs. N/A (76 per cent as organic N), 5845 lbs P/A, 10,785 lbs. K/A and 11,285 lbs. Cl/A. Soil samples taken in April, 1973, following 198.7 T/A, showed that nitrates had moved only to 5'. Chlorides had moved to 8'. Ammonia P, K and Na had accumulated in the 0-1' layer. Following 343.5 T/A, the 1974 sampling showed that some nitrates had moved to 6'. However, nitrate concentrations in the 1-2, 2-3, and 3-4' depths were very low and indicate that denitrification could have occurred. Soil water samples revealed nitrate concentrations under the manure area to be 50 per cent less than those from the fallowed border area until August, 1973. Since then nitrate concentrations under each have been similar. Chloride concentrations were about 3 times higher under the manure. In 1973, corn yielded 152 bu/A from the manure area and 191 bu/A from the fallowed border area without fertilizer. Additional crop yields and soil and water samples must be taken annually before long-term effects can be determined. (Randall-Minnesota University; Merryman, ed.)

## 2757 - A1, B1, C3, E2 200

## COMPOSITION OF POULTRY MANURE AND EFFECT OF HEAVY APPLICATION ON SOIL CHEMICAL PROPERTIES AND PLANT NUTRITION, BRITISH COLUMBIA, CANADA,

Soil Science Department, British Columbia University, Vancouver, Canada
A. A. Bomke and L. M. Lavkulich
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 614-617.

Descriptors: Poultry, Chemical properties, Crop response, Soil contamination, Waste storage.
Identifiers: Canada, Land disposal.

The lower Fraser Valley of British Columbia, Canada has a poultry population of approximately 8.5 million birds. This is the most densely populated area of the province and one which supports the most intensive agriculture. Thus waste disposal has become an acute problem from the standpoint of environmental quality. Application of large amounts of animal wastes to land and the subsequent growth of crops raises the question of crop quality. A program was initiated to determine: (1) The effect of heavy application of poultry manure on soil chemical properties, drainage waters, and crop composition, and (2) Plant nutrient content of poultry manure deposited and stored in deep pits under laying cages. Adverse effects on vegetation of excessive rates of manure were visually apparent when soil and plant samples were collected from several fields used as manure disposal sites. Available P levels as high as 1100 ppm are indicative of potential problems of excessive manure application. Other soil parameters considered are total N, $NO_3$-N, $NH_4$-N, exchangeable cations, electrical conductivity and pH. In addition, tissue analysis of plants collected from disposal sites and cropped fields is used to indicate possible plant nutrient imbalance due to high manure application rates. Types of vegetation sampled include primarily grasses on the disposal sites, some cropped fields, and raspberries, a crop receiving significant quantities of poultry manure in B.C. Proper use of manure requires knowledge of its composition, which is highly dependent on storage methods. Therefore, an evaluation was made of plant nutrient content of manure deposited and stored in deep accumulation pits under laying cages, a system which is used in most new laying houses in B.C. Samples were collected at 15 cm increments from manure piles with an average depth of 90 cm. Manure from lower increments had been stored up to one year. Results of analysis of the manure are evaluated in terms of changes in plant nutrient content during storage. Application rates of poultry manure and their ensuing effects on soils and crops are dependent on an understanding of the type of management system. (Bomke-Canada)

## 2758 - A1, B2, D4, E2, E3 200

## AN OVERLAND FLOW-LAGOON RECYCLE SYSTEM AS A PRETREATMENT OF POULTRY WASTES,

Biological and Agricultural Engineering, North Carolina State University, Raleigh
M. R. Overcash, J. W. Gilliam, and F. J. Humenik
Managing Livestock Wastes, Proceedings 3rd International Symposium on Livestock Wastes-1975, University of Illinois, Urbana-Champaign, April 21-24, 1975, p. 618-621.

Descriptors: Poultry, Waste treatment, Design, Costs, Terracing, Lagoons, Denitrification.
Identifiers: Overland Flow-Lagoon-Recycle System, Waste water recycling.

A sequential arrangement of process in this caged layer waste management system is presented. Waste from 1400 layers is removed from undercage collection channels once per day by flush water (2500 gal) which is held in a storage tank and released so that flow rates of 15-20 feet per second are obtained initially. A flow velocity of 3-5 ft-sec at the end of the waste collection channel results in effective cleaning. The manure slurry is then mixed in a tank and pumped to a dilution box, from which the wastewater is distributed at the upper end of 3 terrace systems by means of a 4'' x 4'' x 40' long trough with slotted openings at ground level. Two terrace systems are 8 per cent slope, and one is 6 per cent. At 50 foot intervals the overland flow liquid is collected, measured and sampled and then redistributed as described above. The cover crop is predominantly Reed Canary grass and is harvested with yields taken every week. To evaluate the nitrifying mechanisms soil surface samples have been taken and analysed for Nitrosomonas and Nitrobacter. The objective is to select the flow distances and operational parameters which promote nitrification without excessive carbon stabilization in overland flow. Terrace runoff is directed into an 18,000 $ft^3$ unaerated lagoon. This serves as a denitrifying site for nitrates formed in the overland flow. Following this basin is a large holding-polishing lagoon from which water is recycled to the flush reservoir and dilution box. This recycle system does not represent a totally closed system because salt or other toxic elements will build with time necessitating the application of the system liquid to the land and a dilution of the system with fresh water. Design factors, costs, and operational strategies for typically-sized producer systems are included. Several alternative designs for various parts of the overall system are included to enhance applicability to a wider range of producer situations. (Overcash-North Carolina State University; Merryman, ed.)

## 2759 - A1, B1 100

## HIGH RISE POULTRY HOUSES,

New Zealand Journal of Agriculture, Vol. 125, No. 3, p. 71, September, 1972. 2 fig.

Descriptors: Economics, Odor.
Identifiers: High rise poultry houses, New Zealand, Advantages, Disadvantages.

The advantages and disadvantages of high rise poultry houses are discussed as applicable to New Zealand's poultry industry. The advantages include: only annual manure removal is needed (sometimes extended to longer intervals); freedom from offensive poultry odors and flies; easy servicing and cheaper running costs; acceptability to pollution-conscious public. The disadvantages include: higher initial capital costs; vermin control is not easy in the pits; and keeping the pit area free of water can be difficult. (Solid Waste Information Retrieval System)

## 2760 - B3, E3 100

## POULTRY MANURE AS A LIVESTOCK FEED (PART 1),

Dohne Research Institute and Bathurst Research Station
E. J. B. Bishop, P. I. Wilke, W. J. Nash, J. A. G. Nell, et. al.
Farming in South Africa (Pretoria), Vol. 46, No. 11, p. 34-36, February, 1971. 5 fig, 1 tab.

Descriptors: Poultry, Livestock.
Identifiers: Refeeding, Hen-laying manure, Chicken litter, Overeating.

There are two types of poultry manure which can be used as feed for livestock. The first type is hen-laying manure. This product is left under the laying batteries for 4 to 12 months before being removed. It is then dried to improve the storing ability and to eliminate unpleasant odors. The second type of poultry manure is chicken litter and is the result of chickens being raised on absorbent material such as wood shavings, chaffed hay, and straw or peanut hulls. Chicken litter is dry and easily handled as well as clean smelling; therefore it is the most popular livestock feed. These two types of feed vary greatly in most instances but compare favorably with lucerne in total digestible nutrients (50 per cent) and crude protein (13 per cent). Although the nutrient value is good, problems are frequently encountered when poultry manure is first used. Chicken litter is much more readily accepted, and in some cases, overeating may occur. Acceptance of the manure may be increased by adding molasses to the feed for the first few days, and overacceptance can be remedied by inclusion of 20 per cent salt. (Solid Waste Information Retrieval System)

## 2761 - B3, E3 100

## POULTRY MANURE AS A LIVESTOCK FEED (PART 2),

Dohne Research Institute and Bathurst Research Station
E. J. B. Bishop, P. I. Wilke, W. J. Nash, J. A. G. Nell, et. al.
Farming in South Africa (Pretoria), Vol. 46, No. 12, p. 49, 51, 53, March, 1971. 4 tab.

Descriptors: Poultry, Livestock.
Identifiers: Refeeding, South Africa.

Farmer utilization of poultry manure in South Africa, which is increasing, includes the use of sun-dried laying-hen manure in a large steer-fattening project, the use of chicken litter to supplement the feed of beef-breeding cows, and the use of poultry manure to supplement the diet of sheep-stud rams, ewes, and lambs. Though the extreme drought gave impetus to the use of this feed supplement, experimental results now indicate that the use of poultry manure supplies vital protein, phosphorus, and energy cheaply. As a winter supplement to cattle and sheep on winter sourveld, it is both useful and economical. Usually the poultry manure is mixed and fed with feeds such as molasses meal, maize meal, and milled hay. Though molasses provides palatability and is used as a binding agent, some farmers now are using poultry manure without the molasses and are processing it into cubes. It can be made with chicken litter, or with a mixture of 20 per cent laying-hen manure, maize meal, and teff hay, which was found to be acceptably palatable, durable, and fracture-free. However, the cubed rations cost more than the uncubed feed. Where laying-hen manure does not constitute the major proportion of the total diet, it can be used with safety for the feeding of breeding stock. (Solid Waste Information Retrieval System)

### 2762 - A5, B1 100

### MANURE HANDLING SYSTEMS AND ENVIRONMENTAL CONTROL FOR CONFINED DAIRY HOUSING,

Department of Agricultural Engineering, Minnesota University, St. Paul
D. W. Bates
Journal of Milk and Food Technology, Vol. 34, No. 3, p. 129-132, March, 1971. 6 ref.

Descriptors: Dairy industry, Environmental control, Odor, Costs, Ventilation.
Identifiers: Waste handling.

Odor and the appropriate time of disposal are two of the most difficult waste problems facing dairymen. Handling systems may range from a gutter cleaner and daily hauling with a manure spreader to extend storage in concrete tanks whose contents are pumped and spread periodically. Daily hauling requires the lowest investment in equipment, but has the disadvantage of possible higher labor costs and the hazard of encountering unfavorable weather, soil, or crop conditions. Slat floors in warm freestall barns, or gutters with grated bottoms in conventional stall barns, both with under-the-building manure storage, offer suitable systems for manure handling with a minimum of labor. Carefully planned ventilation systems of high capacity must be provided for all confined units. Manure containing little bedding deposited in the end of a 150,000-gal tank will distribute itself under its own weight. Waste heat from the dairy barn ventilation system can be used to prevent the manure from freezing. Cost estimates of various methods are included. (Solid Waste Information Retrieval System)

### 2763 - A1, B1, F3 100

### ROLE OF THE DAIRY AND FEED INDUSTRY IN ENVIRONMENTAL POLLUTION CONTROL,

Environmental Health Technology Department, Broome Technical Community College, Binghamton, New York
D. F. Newton
Journal of Milk and Food Technology, Vol. 33, No. 12, p. 568-570, December, 1970. 4 ref.

Descriptors: Dairy industry.
Identifiers: Food industry, Pollution control.

There are three roles which the dairy and food industry assumes—the role of a potential or actual polluter, the role of an educator, and the role of a community leader. In St. Lawrence County, New York, the New York State Health Department, in its initial water pollution survey of that region conducted in 1960 cited no less than 15 dairies as polluters. The industry also contributes to air pollution, and produces significant quantities of solid waste, indirectly contributing to land pollution. Wastewater from milk houses and milking parlors and sanitary sewage from farm houses constitute potential pollutants on dairy farms as does wastewater from milk and food processing plants. Boilers and heating facilities in food processing plants are potential sources of pollutants. Dairy and poultry farms produce enormous tonnages of manure. Processing plants produce much solid waste such as vegetable and fruit trimmings and spoiled food. It is suggested that dairies can print statements about pollution control on milk cartons. Administrative and supervisory personnel from the dairy and food industries could participate in Chamber of Commerce programs which now include pollution control activities. (Solid Waste Information Research System)

### 2764 - B1, D4, E2 100

### THE REMOVAL OF ANIMAL EXCREMENTS FROM MASS-STOCK FARMS AS A WATER ECONOMY PROBLEM,

K. Th. Rager
Wasser und Boden, Vol. 24, No. 5, p. 131-134, May, 1972. 5 tab.

Descriptors: Fertilizers, Nitrogen, Calcium, Sewage treatment, Netherlands.
Identifiers: Land disposal.

Normally the excrements from animals are removed in agriculture by using them as manure on the fields. However, if the number of animals passes a certain limit it is no longer possible to use the feces in rural areas since there is the danger of over-fertilization owing to the high nitrogen and calcium concentrations in the excrements. For this reason mass-stock farms have to remove the excrement by means of biological sewage treatment plants. From 1968 to 1969, 27 such biological sewage plants have been constructed in the Netherlands, which have the longest experience in this field. A biological sewage plant for animal excrements furnishes about 49 per cent of surplus sludge when treating beef dung, about 9 per cent surplus sludge when treating calf dung, and 40 per cent when treating pork dung. The BOD values in these plants correspond to the normal requirement of 25 mg per 1. About 90 per cent of P and N are eliminated at a sludge load of 0.03 kg per kg dry substance. Another method to dispose of animal excrements applied mostly in the USA, is the plow-furrow-cover method. This method however does not use the excrements as manure but disposes of them in a special kind of sanitary landfill. (Solid Waste Information Retrieval System)

### 2765 - A1, E2 700

### ANIMAL WASTES: PHYTOTOXIC EFFECTS ON PLANT GROWTH; INFLUENCE ON THE FEEDLOT SOIL PROFILE,

G. E. Schuman
PhD Dissertation, Department of Agronomy, University of Nebraska, May, 1974, 56 p. 13 fig, 14 tab, 44 ref.

Descriptors: Phytotoxicity, Crop response, Feedlots, Potassium, Soil permeability, Germination, Groundwater pollution.
Identifiers: Seedling development, Land disposal.

Extracts were taken from beef cattle manure and analysed by bioassay techniques to determine the effects of such extracts on the germination and seedling growth of wheat and sorghum. Distilled water, acetone, methanol, ether, and 2N HC1 were used in performing these extractions. The water extract stimulated seed germination but reduced seedling development due to the high salt content of the extract. Of the acids identified and quantified by the ether extract, propionic acid was found to stimulate seedling development at levels of 200 ug/ml or less. However, the fatty acids, in combination, had a detrimental effect. Soil profile samples were taken from a river-basin feedlot and adjacent field in order to determine the effect of the cattle-feeding operation on the chemical properties of the soil and their effects on the future uses of the soils. Feedlot soil profiles revealed an exchange complex in the top 15 cm. of the soil that was saturated with potassium. This zone of high exchangeable potassium and organic matter limited water permeability. The presence of nitrate was virtually nil beneath this impermeable layer. Undisturbed soil columns that were obtained from the feedlot seemed to confirm that the potassium probably plays a role in the formation of an impermeable zone. The maintenance of this impermeable layer is necessary for prevention of pollution of groundwater by cattle feedlots. (Penrod-East Central)

### 2766 - A1, B2, D1 700

### AQUATIC ECOLOGY OF SWINE WASTE LAGOONS BEFORE AND AFTER ARTIFICIAL AERATION,

J. A. Tranquilli
PhD. Dissertation, Illinois, Urbana-Champaign, September, 1974, 172 p. 18 fig, 31 tab, 61 ref.

Descriptors: Lagoons, Aeration, Fish, Mosquitoes, Water quality.
Identifiers: Swine.

Studies were conducted in order to: (1) monitor water quality parameters in three lagoons at the University of Illinois and determine the effects of artificial aeration on the parameters studied; (2) determine whether fish could survive, grow, and reproduce under the extreme conditions present in swine waste lagoons; (3) determine the effects of various control methods on mosquito populations plaguing livestock waste lagoons. The study revealed that 13 of the water quality parameters were significantly different between stations. There was a significant negative correlation between water temperature and both total kjeldahl nitrogen and ammonia nitrogen at all stations. Dissolved oxygen (DO) concentrations at the 1-foot level, DO concentrations at the bottom, and the depth of the water were the only parameters which were significantly different between aerated and unaerated stations within the three lagoons. Beneficial and detrimental effects of artificial aeration systems are discussed. Unsuccessful reproduction by adult carp in the aerated lagoons indicated that the adults were severely stressed and failed to reproduce or that environmental conditions did not favor survival of the zygotes. The survival and growth of carp fingerlings in the MD lagoon was poor in comparison to that in unpolluted Illinois ponds. At present the greatest potential for fish culture in concentrated swine waste lagoons seems to be the biological control of insect pests. Either manual or herbicide removal of flooded vegetation from the shoreline of waste lagoons may represent a practical method of mosquito control. Applications of Flit MLO and malathion during 1972 suppressed mosquito larvae populations for about one week. (Penrod-East Central)

### 2767 - A9 100

### BACTERIAL AND FUNGAL FLORA OF SEAGULL DROPPINGS IN JERSEY,

Jersey General Hospital, St. Helier (England)
J. Cragg and Y. M. Clayton
Journal of Clinical Pathology, Vol. 24, No. 4, p. 317-319, 1971. 12 ref.

Descriptors: Animal wastes (Wildlife), Bacteria, Fungi, Waste identification, E. coli, Streptococcus, Yeasts, Salmonella, Shigella, Seashores, Sampling, Laboratory tests, Gulls.
Identifiers: Seagull, Mycology, Jersey.

In Jersey 166 fresh and 122 dried seagull droppings were obtained and studied locally and in London for the presence of bacteria and fungi of potentially pathogenic nature. There were no salmonella or shigella bacteria isolated from the two groups but there was a high proportion of Candida albicans obtained from the fresh material (21.7 per cent) and only 1.6 per cent from the dry faeces. Cryptococcus neoformans and Histoplasma capsulatum were not found in either dry or fresh droppings. The normal bacterial and fungal flora of the seagull was established and it is considered that the C. albicans in fresh gull droppings would not materially increase albicans infections in man. (Bundy-Iowa State)

### 2768 - A5, B2, C1, D4, E1 700

### CHARACTERISTICS OF CHICKEN WASTES AND DISPOSAL BY LAGOONING,

C. R. Wieting
Unpublished M.S. Thesis, Civil Engineering Department, South Dakota State College, 1964, 64 p. 7 fig, 15 tab, 33 ref.

Descriptors: Physical properties, Chemical properties, Biological properties, Poultry, Lagoons, Waste disposal, Odor, Sampling, Biochemical oxygen demand, Chemical oxygen demand, Nitrogen.

The purpose of this research was to determine characteristics of fresh chicken manure so that adequate treatment and disposal systems could be designed. Another research objective was to examine and evaluate an existing poultry manure lagoon's ability to stabilize organic chicken wastes. The following conclusions were based on observations and calculations made while evaluating the anaerobic lagoon used for chicken manure disposal. (1) An anaerobic lagoon should be designed to provide a minimum of 10 to 15 cubic feet [illegible] volume per chicken. (2) The depth of an anaerobic lagoon should be at least three feet. An adequate water supply must be available for maintaining this depth. (3) Offensive odors are prevalent when uncovered manure solids project above the lagoon's water level, but nuisance odor levels are practically non-existent during the major part of the summer. (4) Good mixing action of chicken wastes at the point of discharge to the lagoon is essential. (5) Solids buildup to the extent of threatening the useful life of a lagoon does not appear to be a major problem with proper solids dispersion. (Merryman-East Central)

### 2769 - A1, A4, B1, E1, E2 100

### THE DISPOSAL OF INTRACTABLE INDUSTRIAL AND AGRICULTURAL WASTES–CONCLUSION,

Effluent and Water Treatment Journal, Vol. 10, No. 3, p. 147-149, March 1970.

Descriptors: Agricultural wastes, Industrial wastes, Water pollution, Waste disposal.
Identifiers: Gravel pits, Land disposal.

Past disposal of intractable wastes has been founded on the short haul of wastes from source to the nearest available tip site. The disposal of wastes to ground was, still is, and will be for a considerable time in the future, the cheapest method of disposal. Some of the existing gravel pit sites suffer from the shortcoming of not having impermeable bottoms, and most suffer the disadvantage of having impermeable sides. These pits could feasibly be rendered fit for waste disposal if the permeable bottoms and/or sides are sealed with clay or other impervious material. Ground disposal methods' greatest success will be achieved when four requirements are met. Firstly, the site used must not result in the transfer of polluting matter into ground or surface water. Secondly, the site should be dry. Thirdly, circumstances must exist or be provided so that liquid wastes disposed of can be absorbed in solid material to prevent any significant accumulation of waste liquor on the site. Fourthly, the site should be remote from dwellings and public open spaces. The best site for ground disposal is marshland area, founded on impervious soil where domestic refuse has been previously dumped. The second best site is the clay pit. Another method of disposal is application on agricultural land. (Cartmell-East Central)

### 2770 - B1, C1, D1 700

### DRYING CHARACTERISTICS OF FULLY EXPOSED FORMED POULTRY EXCRETA,

T. M. Midden
MS Thesis, Agricultural Engineering Department, University of Kentucky, 1972, 69 p. 17 fig, 10 tab, 32 ref.

Descriptors: Poultry, Drying, Moisture content, Equations, Temperature.
Identifiers: Excreta, Crusting characteristics, Thin-layer drying constant.

Thin-layer drying equations were used to describe the drying characteristics of formed poultry excreta. Tests were conducted in a range of drying air temperatures from 100 degrees to 220 degrees F and with cylinders of manure from .339 to 1.056 inches in diameter. The crusting characteristics of the formed cylinders of manure were determined for drying air temperatures from 500 degrees to 950 degrees F. It was determined that a crust can be formed on the surface of a cylinder of poultry manure when the cylinder is exposed to high temperature drying air. The time required to form a stable cylinder increases with increasing cylinder diameter and decreases with increasing temperature. (Cartmell-East Central)

### 2771 - A2, B1, D1, E1, F2 700

### ECONOMIC IMPACT OF ENVIRONMENTAL QUALITY LEGISLATION ON CONFINED ANIMAL FEEDING OPERATIONS IN OKLAHOMA,

G. R. Cross
MS Thesis, Oklahoma State University, Stillwater, July, 1971, 95 p. 3 fig, 40 tab, 37 ref.

Descriptors: Economic impact, Legislation, Confinement pens, Oklahoma, Costs, Legal aspects, Cattle, Lagoons Poultry, Dairy industry, Agricultural runoff.
Identifiers: Oklahoma Feed Yards Act of 1969, Environmental Quality, Technical aspects, Swine, Land spreading.

A study was undertaken to analyze the economic impact of the Oklahoma Feed Yards Act of 1969 on confined animal feeding operations in Oklahoma. Specific objectives included examination of (1) technical (2) legal, and (3) economic aspects of the passage of the Oklahoma Feed Yards Act of 1969 as related to confined feeding and waste handling. A sample of confined animal feeding operators was drawn from a list of the registered feed yard operators of Oklahoma. These managers were contacted for an interview to obtain the data for this study. Maps and other secondary sources were used to augment these data. After analyzing the data gathered, the author concluded that the pollution problem from confined animal feeding is not as great as the raw numbers of animals would indicate. Another conclusion which this study supported is that legislators must consider the effect of any legislation upon the group to be controlled. The study revealed that most of the effect of the Feed Yards Act was on the fixed costs of the feed yards and that these costs probably could not be passed on to the consumer, but must be absorbed by the feeding operation. Recommendations are given for feeding operations, and for further research and study. (Cartmell-East Central)

### 2772 - A1, B1, E2 700

### ECONOMICS OF ALTERNATIVE WASTE MANAGEMENT SYSTEMS COMPLYING WITH POLLUTION CONTROL REGULATIONS ON BEEF FEEDLOTS IN SOUTHWESTERN MINNESOTA,

C. L. Pherson
Unpublished PhD Dissertation, Department of Agricultural and Applied Economics, University of Minnesota, December, 1973, 152 p. 5 fig, 37 tab, 72 ref.

Descriptors: Economics, Regulation, Legal aspects, Feedlots, Cattle, Minnesota, Agricultural runoff, Costs.
Identifiers: Waste management, Land disposal.

The objectives of this study were to determine the effects of complying with pollution control regulations on the cost and design of a beef feedlot. Other factors studied were: (1) the most "profitable" beef waste management-housing system, (2) the optimal time schedules for beef waste handling operations, (3) the effects of system choice on crop selection and field operation time scheduling, and (4) the effect of Set-Aside or rotating disposal field on farm-feedlot profitability. Study data showed that there may be substantial indirect costs of switching to waste handling systems which comply with pollution control regulations. Both operating expenses and per head investment are greater for small lots than for large capacity facilities. Optimum net returns were provided in most instances by liquid waste handling in cold slotted floor confinement housing. Drylot, scrape barn, and open lot rank in that order with respect to returns to all labor. Returns to all labor will be reduced by using a small rotating disposal field of uncropped land each year, but the reduction is small. The study presented methods for cost reduction in relation to runoff control and other waste management systems. (Penrod-East Central)

### 2773 - A1, B1, E1 400

### THE EDITOR'S NOTEBOOK: ABOUT DISCHARGE REGULATIONS,

The Catfish Farmer, Vol. 6, No. 1, p. 7-8, January, 1974.

Descriptors: Catfishes, Runoff, Permits.
Identifiers: Environmental Protection Agency, Discharges, Requirements.

Most catfish farming is exempted under new EPA regulations. These facilities not subject to NPDES requirements are: (1) closed ponds with discharges only during annual harvesting or during periods of excess runoff, (2) facilities where discharges occur less than 30 days a year, and (3) facilities where flow is continuous but total number of pounds produced per year is less than 20,000 pounds. (Cameron-East Central)

### 2774 - A1, B2, E2 700

### EFFECTS OF OVERLOADING SWINE EFFLUENT ON TALL FESCUE, REED CANARYGRASS, AND CORN,

P. F. Duffner
MS Thesis, Agronomy Department, University of Illinois, Urbana-Champaign, 1974, 90 p. 26 fig, 6 tab, 60 ref.

Descriptors: Effluent, Fescues, Forages, Crop response, Nutrients.
Identifiers: Swine, Application rates, Corn, Soil pH.

To determine the effects of overloading swine manure on cropland, swine manure effluent was applied in high rates to tall fescue and reed canarygrass in a greenhouse experiment. Equivalent amounts of a commercial fertilizer were also applied. Clippings were taken from the plants at 30-day intervals and analyzed. Soil samples were also taken. Factors checked in determining the effects that rate or source of nitrogen has on the plants were: dry yields, tissue nitrate concentrations, soil pH, phosphorus, potassium, and nitrate. As shown by the data collected, plant growth was hindered by applications of effluent over 672 kg N/ha; however, this appeared to diminish with time so that yields could be maintained through split applications. Levels of nitrate high enough to be toxic to animals accumulated in the fescue and canarygrass receiving effluent, although no accumulation appeared in plants on which commercial fertilizer was used. High rates of effluent were also applied in a field experiment to corn. Grain production, tissue nitrate, soil pH, phosphorus, potassium, and nitrate were examined. As the rate of effluent increased, the nitrate concentrations in the cornstalks also increased. Checks were made on the soil at depths of 0 to 15 cm, 15 to 30 cm, and 30 to 90 cm, with no changes in soil pH. The nitrate movement downward was negligible. Irreversible plant damage was done by effluent applications of over 940 kg N/ha, although there seemed to be no appreciable amount of pollution potential at this rate. (Sanders-East Central)

### 2775 - C2, D2 100
### EVALUATION OF PHYSICAL PROPERTIES OF PIG MANURE,

Department of Chemical Engineering, University of Newcastle Upon Tyne
J. R. Backhurst, and J. H. Harker
Journal of Agricultural Engineering Research, Vol. 19, p. 199-207, 1974. 5 fig, 9 tab, 8 ref.

Descriptors: Physical properties, Evaluation, Incineration, Density, Viscosity, Filtration, Slurries, Drying, Moisture content, Odor, Costs.
Identifiers: Swine, Calorific value.

The objective of this study is to evaluate, with emphasis on density, viscosity, and calorific value, the physical properties of pig manure during the course of feeding trials. The feeding trials lasted for 14 weeks. Over this trial period, the densities of the urine and separated feces varied only slightly and mean values of 1016 and 1130 kg/m$^3$ were obtained respectively. The calorific value of the dried feces was found to be 17.9 MJ/kg, which will contribute significantly in any incineration operation. The mean viscosity was determined to be 1.10 mNs/m$^2$ for the trial period. Technical scale tests on filtration and drying of slurries are reported with mean transfer rates of $7.0x10^{-5}$ kg/m$^2$ and $2.2 x 10^{-4}$ kg/m$^2$ respectively. The study indicated that incineration of waste could be within the bounds of a viable commercial proposition, especially taking into account the decrease in total operation costs with reduced moisture content resulting from the contribution made by the calorific value of the dried feces. Long term possibilities indicate that incineration as the sole complete disposal method may prove to be the ultimate solution to the problems involved. (Penrod-East Central)

### 2776 - B1, D1, E3 400
### ENERGY CRISIS FUELS RESEARCH TO DEVELOP ALTERNATIVE POWER SOURCES,

Associate Editor of EDN
J. Bond
EDN Magazine, Vol. 19, No. 3, p. 24-26, February 5, 1974. 2 fig.

Descriptors: Energy, Fuels, Cattle, Gases, Costs.
Identifiers: Manure, Gasification, High-power fuel cell, Solar power.

The energy crunch has generated a great deal of interest in more efficient methods of power production. Three methods were considered in this report. They are: high-power fuel cell, solar power, and cow manure. The first method is eminently practical and not far from realization. The second is a strong contender but needs a lot of effort. The third method might appear impractical at first, but it has been worked out rather carefully and the economics look very good. Hydrogasification of cattle manure could provide large quantities of high-quality pipeline gas. With feedlots containing 50,000 or more head of cattle, reasonably large gas-production plants could be built nearby to eliminate transportation costs. The method selected for gasification is the Hydrane Process. Cost projections indicate that the gas prices (based on free manure) would be reasonable—about 41 cents/MBtu for a plant that has a manure rate of 690,000 lbs/hr. (Cameron-East Central)

### 2777 - A4, B1 600
### GROUND-WATER CONTAMINATION BY DISSOLVED NITRATE,

Geology Department, Missouri University, Columbia
W. D. Keller and G. E. Smith
Presented at 164th Meeting of Geological Society of America, Miami, Florida, 27 p. 3 fig, 3 tab.

Descriptors: Nitrates, Fertilizers, Geochemistry, Missouri, Surveys.
Identifiers: Groundwater contamination, Farm wastes.

This report is concerned with a brief comment on the geochemistry of the $NO_3$ ion and a progress survey of high-nitrate subsurface water in Missouri. Nitrates in Missouri subsurface waters were investigated by collecting water from wells and springs. More than 5,000 water samples were collected and analyzed. Approximately 42 per cent of the samples ranging from 12 to 75 per cent of the samples from individual counties, contained over 5 ppm nitrogen. The dominant source of water-pollutant nitrate in Missouri water table was found to be nitrogenous waste material from farm feed lots. Heavy application of nitrate fertilizers on highly permeable, alluvial soils, may contribute to the nitrate content of water table wells. (Cartmell-East Central)

### 2778 - A2, B1 600
### A HANDBOOK FOR ESTIMATING THE POLLUTION POTENTIAL OF BEEF, DAIRY, SHEEP AND SWINE FEEDLOTS IN THE NORTH CENTRAL REGION,

Agricultural Engineer, 724 East First Street, Fairmont, Minnesota
R. L. Mensch
Project Report for Consulting Work Performed for the Farm Structures Division, Agricultural Engineering Department, University of Illinois, Urbana, June, 1971, 29 p. 18 fig.

Descriptors: Feedlots, Livestock, Agricultural runoff, Cattle, Dairy industry, Sheep, Climatic data.
Identifiers: North Central U.S., Pollution potential, Swine.

The primary objectives in preparing this handbook are: (1) present procedures so that non-engineers can make on-site evaluation of a feedlot's pollution potential, (2) simplify mathematics so they can be performed without a computer or slide rule, and (3) reduce the number of instruments needed in securing field data to a minimum. A literature review was conducted to pull together the various procedures and equations of evaluating a feedlot's pollution potential in various order to provide a continuous evaluation of the system, going from one component to the next. Selected references are cited. Evaluation of a feedlot must include climatic data as well as other factors such as: number of animals, type of animals, ration, percentage of time during the year that the feedlot is in use, feedlot area, lot slope and slope length, and feedlot management. All factors are compiled into a two page worksheet for the computation of feedlot runoff pollution. (Penrod-East Central)

### 2779 - A1, B2, D4, E3 100
### HIGH RATE COMPOSTING OF MUNICIPAL REFUSE AND POULTRY MANURE,

Department of Microbiology, Dunedin, New Zealand
R. G. Bell and J. Pos
Canadian Agricultural Engineering, Vol. 15, No. 1, p. 49-53, June, 1973. 7 fig, 6 tab, 6 ref.

Descriptors: Composting, Municipal wastes, Farm wastes, Poultry, Costs, Recycling, Waste treatment, Waste disposal, Fertilizers, Ammonia, Economics.
Identifiers: Manure.

The work reported here was undertaken to demonstrate the feasibility of composting broiler manure in association with refuse to produce a soil-conditioning agent without the evolution of copious quantities of ammonia. The composting facility consisted of a high-rate composter housed under the same roof as ancillary equipment for the sorting, comminution and blending of municipal refuse with broiler chicken manure. Municipal refuse was sorted to remove metal, glass, plastic and rags, and then passed through a hammer mill. The shredded refuse was then moistened and blended with broiler manure in the ratio of 5:4 by weight. This mixture was treated in a high-rate composting unit for 8 days and then discharged to a stockpile and allowed to mature. The mature compost direct from the stockpile is being evaluated as an aid to the restoration of vegetative cover on a former gravel pit site and reground compost is being tested by the horticultural industry. The cost of producing compost from poultry manure and municipal refuse without presorting amounted to $22.06 per ton. (Cartmell-East Central)

### 2780 - A5, B1, D1 700
### AN INVESTIGATION OF ODOUR CONTROL FOR SWINE BUILDINGS,

J. C. Abercrombie
MS Thesis, University of Guelph, Guelph, Ontario, Canada, 1971, 78 p. 15 fig, 13 tab, 31 ref.

Descriptors: Odor, Confinement pens, Filtering, Dusts, Chemical properties.
Identifiers: Odor control, Swine buildings, Air washer.

An investigation was undertaken with the following objectives: 1. To determine if odours in the exhaust air of swine buildings are carried by particulate materials. 2. To determine which size of particle is most responsible for transporting odours from swine buildings. 3. To examine presently accepted methods of particulate collection and evaluate their usefulness for removing the particulate material from the exhaust air from swine buildings. 4. To determine whether filtering of the exhaust air has any significant use as a method of controlling odour emissions from swine buildings. 5. To investigate the effect of weather conditions and distance on the dispersion of pollutants from a swine building. The particles collected by both the vacuum and electrostatic processes were odorous. The most important fraction of the particulate material responsible for transporting obnoxious qualities appeared to be the fraction between 5 and 20 microns in size. It was found that odours carried in an air-stream could be removed by filtering. In descending order, the following systems were found to be most efficient in removing odour from the air stream: viscous impingement filter plus electrostatic precipitator plus activated carbon filter; viscous impingement filter; dry filter plus electrostatic precipitator; dry filter. (Cartmell-East Central)

### 2781 - A2, B1, C1 700
### AN INVESTIGATION OF THE POLLUTIONAL CHARACTERISTICS OF RUNOFF FROM TWO FEEDLOTS,

P. E. Thormodsgard
M.S. Thesis, South Dakota State University, Brookings, 1970, 74 p.

Descriptors: Agricultural runoff, Feedlots, South Dakota, Sampling, Pollution, Suspended solids, Nitrogen, Phosphorus, Oxygen, Snowmelt, Rainfall.
Identifiers: Land disposal.

The trend toward larger numbers of animals in feedlots has resulted in the concentration of their wastes. Consequently waste management has become a major problem. The general objective of this investigation was to explore the pollution characteristics of runoff from two feedlots in eastern South Dakota. The specific objectives were: (1) To determine the quantity and quality of feedlot runoff from the Animal Nutrition unit and the Dairy Research and Production unit at South Dakota State University, (2) To investigate the spring feedlot runoff resulting from snowmelt as well as the runoff produced by spring rainfall, (3) To determine the pollutional characteristics attributable to the suspended matter in the feedlot runoff in order to assess the effectiveness of settling in reducing the waste concentrations in feedlot runoff. It was concluded from the investigation that: (1) High concentrations of total and suspended solids, nitrogen, phosphorus, and oxygen-demanding material were present in the feedlot runoff, (2) The snow removal operation in the beef pens and the dairy confinement lot reduced the volume of snowmelt runoff from each unit, (3) Population equivalent values of the total animal waste load produced on the two feedlots were not a valid assessment of the actual pollution attributable to the runoff from these units, (4) The water pollution resulting from the feedlot runoff from the two units was probably negligible during this investigation, (5) The centrifuging procedure was effective in reducing the waste concentrations of the runoff samples, (6) Diversion of feedlot runoff onto cropland may be a satisfactory means of handling feedlot runoff in some situations. (Battles-East Central)

### 2782 - A3, A4, E2 100

### LAND SPREADING OF MANURE FROM ANIMAL PRODUCTION UNITS,

Department of Agricultural Engineering, The University of Newcastle upon Tyne
J. R. O'Callaghan, K. A. Pollock, and V. A. Dodd
Journal of Agricultural Engineering Research, Vol. 16, No. 3, p. 280-300, September, 1971. 6 fig, 13 tab, 22 ref.

Descriptors: Computer models, Waste disposal, Fertilizers, Cattle, Water pollution.
Identifiers: Land disposal, Loading rates, Manure, Swine, Hydraulic loading, Chemical loading.

A computer simulation model has been developed to determine manure output for a group of pigs a. a function of diet. The results of this model are incorporated into a second model designed to simulate land spreading of the manure. One of the factors to be considered in land spreading is the hydraulic loading of the soil; this is assessed by comparing actual evapotranspiration with historical rainfall figures and allowing the manure to make up any soil moisture deficiency. Chemical loading is determined by assessing the levels of nitrogen, potassium, and phosphorus that will be removed by the crop or fixed in the soil. Any excess applied over this figure will result in groundwater or runoff contamination. Because of increased soil saturation and decreased organic activity in cold weather, spreading during winter months is not advisable. The farmer should never apply more slurry to the soil than can be immediately absorbed. Crops also affect the maximum permissible chemical loading; intensive grass production permits the maximum loading. To plan a waste disposal system, levels of manure output and its chemical composition must be established. The hydraulic and chemical loading maximums for each field and each crop will allow the minimum acreage required for waste disposal to be calculated. By avoiding the need to purchase fertilizer, the farmer can realize cash value from his manure. For example, if a farmer fattens 5,000 hogs per year, the total cash value of the nitrogen, potassium, and phosphorus content of the manure would be 5000 pounds sterling, with spreading costs of about 1,700 pounds sterling. (Solid Waste Information Retrieval System)

### 2783 - A1, B1, E2 200

### MANURE-HANDLING CAPACITY OF SOILS FROM A MICROBIOLOGICAL POINT OF VIEW,

Department of Environmental Biology, Guelph University, Guelph, Ontario
J. B. Robinson
Presented at Canadian Society of Agricultural Engineers Conference, Charlottetown P.E.I., June 27, 1972, Paper No. 72-210, 18 p. 4 fig, 18 ref.

Descriptors: Soils, Microbial degradation, Nutrients, Phosphorus, Nitrogen, Pathogens.
Identifiers: Manure.

The criterion for handling capacity of a soil may be taken to be "the ability of the soil microflora to assimilate waste without permitting excessive leakage of nutrients and other undesirable components from the system." This ability is affected by temperature, moisture content, degree of aeration, pH, and initial microbial population. The components of most concern are carbon, phosphorus, nitrogen, and pathogenic organisms. Of these, nitrogen is usually the most critical. Due to the complexities of microbial conversions of nitrogen in mineralization, nitrification, and denitrification, generalizations are frequently erroneous and many contradictory results have been reported in the literature. (Whetstone, Parker, Wells-Texas Tech University)

### 2784 - B1, E2 100

### REGIONAL MANAGEMENT OF ANIMAL MANURES--A MODEL FOR COLLECTION, STORAGE LOCATION AND DISTRIBUTION,

Agricultural Institute, Dublin
V. A. Dodd, D. F. Lyons, and J. R. O'Callaghan
Journal of Agricultural Engineering Research, Vol. 19, p. 233-244, 1974. 1 fig, 2 tab, 4 ref.

Descriptors: Mathematical models, Waste storage, Economics, Systems analysis, Poultry.
Identifiers: Land spreading, Swine, Collection.

It is proposed that a centralized storage facility should be provided for a group of pig and/or poultry units. The manure that is collected and brought to the central store can be disposed of by spreading on land in a separate operation. A mathematical, analytical model is constructed to determine the best place to locate the central store, and to determine the number of tanker wagons needed to collect and spread the manure. The model was applied to a specific region containing 58 pig fattening units. Results showed that the system may be economically attractive, having as additional advantages the minimization of pollutional hazards and the relieving of the pig or poultry farmer of the task of manure management. (Solid Waste Information Retrieval System)

### 2785 - D2, D3, E3, F1 200

### AGRICULTURAL WASTES--AN ENERGY RESOURCE OF THE SEVENTIES,

Bureau of Mines, U.S. Department of the Interior, Washington, D. C.
William L. Crentz
Presented at the World Farm Foundation Symposium, Anaheim, California, December, 1971, 25 p. 2 fig, 8 tab, 15 ref.

Descriptors: Recycling, Energy, Fuels, Gases, Oils, Autoclaves, Costs, Cellulose.
Identifiers: Pyrolysis.

The Department of Interior's Bureau of Mines has developed two processes for utilizing the cellulose from farm and urban wastes: pyrolysis and autoclaving. In the pyrolysis process, wastes are passed through a high temperature (200-900 degree C) retort system. A recovery train removes tar and heavy oils, a lighter oil, an aqueous product and tar fog and vapor mists. The remaining gases pass through scrubbers, an acid tower, and an alkali wash before emerging as a usable product. Pollution from the plant is negligible. For a large plant, the costs of pyrolysis are much less than the costs presently being paid by cities for incineration ($8 to $12 per ton) or landfill ($6 to $8 per ton). In the autoclaving process, the wastes are converted to low-sulfur oils by treatment with carbon monoxide and water under high pressures and temperatures. The most likely end use of this fuel oil would be for generation of electricity. (Cannon-East Central)

### 2786 - D4, E2, E3 100

### TREATMENT AND DISPOSAL OF ANIMAL WASTES,

Cornell University, Ithaca, New York
R. C. Loehr
Industrial Water Engineering, Vol. 7, No. 11, p. 14-18, November 1970. 3 fig.

Descriptors: Waste treatment, Waste disposal, Animal wastes, Aerobic treatment, Anaerobic conditions, Drying, Agricultural runoff, Nitrification-denitrification.
Identifiers: Oxidation ditch, Holding tank, Composting.

Intensive livestock production methods are becoming big pollution problems. Nine animal waste treatment and disposal methods are discussed. System one is daily disposal on the land without a holding tank and is common with many dairy operations. An aerobic unit is substituted for the holding tank in System two. In an attempt to reduce the size of the aerobic unit, System three incorporates an anaerobic unit which can act as a surge tank and a repository for the heavier solids. Systems four and five are in-house ditches. System number four, an in-house oxidation ditch system, offers the advantage of inexpensive construction since it is a part of the confinement building. System five incorporates a non-aerobic in-house system. System six separates the semi-solid wastes from the washwaters at the source. Systems seven-nine are based on the drying and composting of animal wastes but require a market for the product. These markets are not yet available on a general basis. The above systems will remove most of the organic-oxygen-demanding material but not the inorganic nutrients. Two engineering techniques are available to reduce the quantity of nitrogen in the wastes at the production site. These are nitrification-denitrification and ammonia release. Systems to handle runoff are discussed. (Kehl-East Central)

### 2787 - B3, D4 100

### WINTER HIGH RATE COMPOSTING OF BROILER MANURE,

Department of Environmental Biology, University of Guelph, Guelph, Ontario
Bell, R. G. and Pos, J.
Canadian Agricultural Engineering, Vol. 13, No. 2, p. 60-64, December, 1971. 10 fig, 2 tab, 5 ref.

Descriptors: Winter, Farm wastes, Waste treatment, Poultry, Aeration, Temperature, Weather, Nitrogen, Carbon.
Identifiers: Composting, Manure, Broilers.

An aerated horizontal silo type composter was constructed to test the feasibility of high rate composting of broiler manure during the winter months. It was concluded that high rate composting is possible outside during the winter when supplementary heating equipment is used. It was hampered by snow buildups and freezing rain which necessitates a roof for maximum efficiency. A forced aeration system proved to be necessary for high rate composting, and ideally the composter should be loaded daily. The use of ground garbage will increase the carbon to nitrogen ratio and produce a better compost. The compost itself proved to be reasonably consistent, but several modifications and adjustments are necessary before the high rate composter could be considered successful. (Russell-East Central)

### 2788 - B1, D4 100
### THE FLOW OF SOLID WASTES IN PIPELINES,

Compost Science, Vol. 8, No. 2, p. 11, Autumn 1967-Winter 1968. 1 tab.

Descriptors: Solid wastes, Hydraulic transportation, Pipelines, Municipal wastes.
Identifiers: Feedlot wastes, Composting.

Among the research projects now being supported under the Solid Waste Program of the Public Health Service is a study by Dr. Iraj Zandi of the University of Pennsylvania who is exploring the pipeline collection and transportation of solid wastes. Despite the potential of solid pipeline systems, the inability to predict accurately the headlosses that will occur under an assumed condition has been one of the factors impeding the development and widespread use of hydraulic transportation. Experiments have shown that ground-up municipal refuse could be mixed with a small amount of water from the city sewer system and pumped out of the city. Pipelines would only have to be 2-in. in diameter to carry the wastes of a town with a population of 10,000 to 15,000. In the future, magnetic and centrifugal sorting devices may be used to separate metals, glass and plastics for salvage. The remaining organic material could be mixed with sludge from sewage treatment plants and manure from feedlots, and the entire mixture composted. A slurry of 40 per cent solid wastes may be a good input to a composting system. Industrial installations of pipeline transportation in the U.S. and Europe are listed. (Solid Waste Information Retrieval System)

### 2789 - A9, B2, E3 100
### EFFLUENT SPRAY DISEASE RISK,

Senior Research Officer (Pollution), and Scientific Liaison Officer, of the Meat Industry Research Institute, Hamilton, New Zealand
C. F. Denmead and G. R. Bentley
New Zealand Journal of Agriculture, Vol. 125, No. 4, p. 23, October, 1972. 1 fig.

Descriptors: Health, Diseases, Salmonella
Identifiers: Spray irrigation, Cattle manure, New Zealand.

This article discusses the potential health hazards involved in spraying microorganisms from cattle dung around pastures. Salmonella is one of the dangerous organisms which can be found in cattle dung. In the case of spray irrigation this material is diluted and sprayed thinly over a large area. Whether or not an animal becomes infected depends on the number of live organisms ingested. In the case of a milk infection, milk production can be reduced. A serious infection could mean complete loss of production or the death of the animal. The following measures will assist in stopping the spread of infection: irrigating on ploughed ground; minimizing spray drift; and waiting a few months before using a sprayed pasture. By careful management of cowshed waste disposal, farmers can reduce the spread of cattle diseases. (Solid Waste Information Retrieval System)

### 2790 - A9, B1 100
### TOXICITY OF NITRITE TO CHANNEL CATFISH,

Fisheries Research Laboratory and Department of Zoology, Southern Illinois, University, Carbondale.
M. Konikoff
The Progressive Fish-Culturist, Vol. 37, No. 2, p. 96-98, April, 1975. 1 fig, 3 tab, 13 ref.

Descriptors: Catfishes, Nitrites, Ammonia, Toxicity.

A study concerning the toxicity of nitrite, an intermediate compound formed during the biological oxidation (or nitrification) of ammonia (a major waste product of fishes), is reported in terms of toxic effects on channel catfish. Channel catfish, which had been held for at least four weeks in raceways, were added to five aquariums filled with 40 liters each of dechlorinated tapwater. The fish were added at an average density of 284 grams per aquarium. Average fish weight was 40 grams. The fish were acclimated for 24 hours. Then appropriate amounts of sodium nitrite solution were added slowly to the aquariums. Groups of 6-10 fish were exposed to concentrations of 15, 20, 25, 30, and 35 mg/l of $NO_2$ for 4 days. This was repeated until 28 fish had been exposed to each concentration. Other groups of fish were exposed to 5, 10, 40 and 45 mg/l of $NO_2$ with fewer replications. Dead fish were removed at 24, 48, 72, and 96 hours. Temperature, dissolved oxygen and pH were measured. The median tolerance limit for each time period was calculated from a regression equation which was determined for the log of the nitrite concentration and the per cent fish surviving. The easiest method of confirming nitrite toxicity is to inspect the color of the fish's blood, which will become chocolate-brown under toxic conditions. The wide range of tolerances exhibited by fishes to nitrite poisoning indicates that nitrite might be used as a selective fish toxin. (Merryman-East Central)

### 2791 - A1, B1, C3, D4, E1 300
### THE TREATMENT OF PIGGERY WASTES,

L. Littlejohn (ed)
The Treatment of Piggery Wastes, Scottish Farm Buildings Investigation Unit, North of Scotland College of Agriculture, June, 1975, 66 p. 28 fig, 15 tab, 21 ref.

Descriptors: Waste treatment, Waste disposal, Anaerobic lagoon, Anaerobic digestion.
Identifiers: Swine, Scotland, Below-house oxidation ditch, Surface aerator, Oxidation ditch.

Treatment and disposal of piggery wastes in Scotland is not without problems. The ideal method of animal wastes disposal is to recycle them by application to the land. But because of the complexities of modern agricultural production and pressures from non-agricultural sectors of the community there are increasing numbers of situations arising in which it may be desirable to put animal wastes through some form of treatment before disposal, whether to the land or elsewhere. The objectives of such treatment may range from simple deodorization to the production of a final product acceptable by sewage authorities or river boards. This publication describes the problems that piggery wastes present. A description of the physical, chemical and biological properties of piggery wastes is given. Field scale experimentations with (1) Below-house oxidation ditch, (2) Surface aerator, (3) Anaerobic lagoon, (4) Independent oxidation ditch, and (5) Anaerobic digester are presented. Results of development work utilizing these treatment systems is reported. (Merryman-East Central)

### 2792 - A1, E2 700
### THE EFFECT OF INCORPORATED ANIMAL MANURE AND pH ON THE SOLUBILITY OF SOIL MANGANESE,

T. M. Taukobong
MS Thesis, Tuskegee Institute, May, 1973, 79 p. 26 fig, 14 tab, 73 ref.

Descriptors: Manganese, pH, Plant response, Toxicity, Soil analysis, Lime.
Identifiers: Manure, Land disposal, Rye, Millet.

An investigation was conducted to study the relationship of pH and animal manure to the solubility of manganese in the soil, and to determine if high application rates of manure to the soil would result in manganese toxicity in plants. Several studies were conducted. In one such study, lime was added to soil samples to give pH values from 4.2 to 6.0 and in a second study, manure of 0 to 120 tons per acre were added to the soil. The soils were incubated, sampled, and analyzed for soluble, exchangeable and easily reducible manganese. In another study, the solubility of manganese was studied as indicated by its uptake in rye and millet. The following conclusions were drawn from these studies: (1) Manure addition to soil results in drastic change of soil pH. (2) The action of manure in causing manganese retention may be twofold; partly due to the increase in pH and partly due to the complexing of the metal. (3) Exchangeable manganese, and to a lesser extent water soluble manganese, seems to be the fraction of soil manganese most susceptible to changes in pH and the amount of manure in the soil, while the easily reducible manganese does not readily respond to these changes. (4) When added to the soil in conjunction with lime, manure tends to reduce the drastic effect of lime on soil manganese. (5) There is no evidence that addition of manure could result in production of toxic amounts of manganese in the soil. (Sanders-East Central)

### 2793 - A9, B3, D2, E3 400
### CHICKEN LITTER COW FEED,

R. Carmody
The Farm Quarterly, Vol. 19, p. 52-53, 92, 94, Fall, 1964. 1 fig.

Descriptors: Feeds, Litters, Poultry, Cattle, Maine, Performance, Costs, Economics, Legal aspects, Scours.
Identifiers: Refeeding.

Under drastic cost conditions, Maine farmers are forced to find a cheap feed so they can stay in production. Some think that chicken litter may be the answer. Results have revealed that by incorporating chicken litter into cattle feed, birth weights may be increased and calf scours may be reduced. However, care must be taken to keep the feed dry, as it becomes extremely unpalatable when wet. Dr. Brugman of the University of Maine is conducting tests on the utilization of poultry litter in cow feed. Although he isn't ready to release the data on his digestion trials, he did state that digestibility of the material was remarkably high. Feed samples made from laying-house litter have lignin content slightly under the 4 per cent figure. The doctor also stated that two things are important in the use of the litter and they are: (1) energy must be added to the ration, and (2) thorough mixing is essential. He further stated that although research data is still needed on the subject, chicken litter shows real promise as a feed for beef cow herds and for dairy replacements. Some conflict with Maine law may arise in feeding litter to producing dairy cows so its best use may be in raising replacement stock. One other problem was noted and that was the removal of metal trapped in the litter. One study showed that the primary cost in going to this feed was the purchase of a Gehl protable hammer mill and mixer in which the feed may be thoroughly mixed, and which can be hauled to the field and unloaded into the big feeders. (Penrod-East Central)

### 2794 - A1, D1, E3 100
### SOLIDIFICATION OF SLUDGES WITH PORTLAND CEMENT,

Department of Civil Engineering, Clarkson College of Technology, Potsdam, New York
E. A. Cassell and T. W. Walker
Journal of Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 96 (SA1), p. 15-26, February, 1970. 7 fig, 7 tab, 13 ref.

Descriptors: Poultry, Portland cements, Fly ash, Leaching, Phosphates.
Identifiers: Sewage sludge, Solidification, Soil conditioners.

A report was made on research to investigate the solidification of sewage sludge and chicken manure in a matrix of Portland cement and fly ash. It was suggested that the solidified matrix could serve as a controlled nutrient release soil conditioner. The rate of phosphate leaching from the matrix, the compressive strength of the matrix, and the time required for the mix to set were influenced by the fly ash to cement ratio, the sludge (or manure) to cement ratio, and the water to cement ratio. (McQuitty and Barber-University of Alberta)

**2795 - A1, A5, B1, D4, E2 400**

## FINALLY A CREATIVE, PROFITABLE SOLUTION TO AGE OLD WASTE PROBLEM,

L. Richardson, Editor
Big Farmer, Vol. 44, March, 1972, 2 p. 5 fig.

Descriptors: Cattle, Municipal wastes, Odor, Crop response.
Identifiers: Swine, Land disposal.

Land disposal of hog, cattle, and urban sludge in the right proportions has eliminated odors in the operation of a project at Richmond, Illinois. Corn yields are reported to have increased from 40 bu to over 100 in three years. (Whetstone, Parker, and Wells-Texas Tech University .)

**2796 - A1, E2 100**

## THE DISPOSAL OF COPPER-ENRICHED PIG-MANURE SLURRY ON GRASSLAND,

Department of Soil Science, University of Aberdeen
T. Batey, G. Berryman and C. Line
Journal of the British Grassland Society, Vol. 27, No. 3, p. 139-143, 1972. 8 tab, 16 ref.

Descriptors: Copper, Slurries, Toxicity, Soils, pH.
Identifiers: Swine, Herbage.

Manure slurry from swine that have been fed copper-enriched diets was applied to land located at the National Institute of Research in Dairying at Shinfield. The slurry was applied in May, June, and July of 1966 at rates of 5000 gal slurry ac and 10,000 gal slurry ac. The soil in the slurry disposal area, as well as the herbage grown there, was analyzed for possible effects. Although copper levels increased in the soil, the levels varied in herbage and appeared to be affected by the rate of grass growth. It appears that there is little risk of copper toxicity following copper-enriched slurry applications; however, to avoid possible hazards from copper buildups in the soil, a maximum annual application of 8.5 lb/ac copper is recommended until more is known about the availability of copper in slurry to crops and grass. (Penrod-East Central)

**2797 - A2, B1, F2 300**

## MANAGEMENT AND CONTROL OF BEEF FEEDLOT WASTE,

Agricultural Research Service, U.S. Department of Agriculture.
O. E. Cross, and C. B. Gilbertson
Farm, Ranch, and Home Quarterly, Nebraska Agricultural Experiment Station, Lincoln, p. 20-21, Winter, 1969. 2 fig.

Descriptors: Feedlots, Cattle, Nebraska, Regulations, Agricultural runoff, Water pollution.
Identifiers: Detention ponds, Rainfall.

Feedlot owners are being given the legal responsibility for insuring that their operation does not contaminate Nebraska's water. The Water Pollution Control Council of the Nebraska State Department of Health has been charged with setting up regulations to maintain Nebraska's water quality. Since information on the most effective ways to dispose of feedlot waste was not available, the Nebraska Livestock Feeders Association and its Pollution Control Committee were given two years to research and develop information on which regulations could be based. Several projects are underway to determine the efficiency of several different systems of waste management. Four systems are discussed which examine several different aspects of feedlot waste management. These systems cover runoff collection and treatment, movement of solids on dirt lots, and various methods of loader cleaning. Rainfall, its duration and intensity is recorded for use in the analysis. (Penrod-East Central)

**2798 - A1, E2 100**

## EFFECT OF NITROGEN AND FARM YARD MANURE ON FINGER MILLET ELEUSINE CORACANA (L) GAERTN,

Department of Botany, Tamil Nadu Agricultural University, Coimbatore-641003, INDIA
P. Rangaswamy
Madras Agricultural Journal, Vol. 60, No. 8, p. 949-952, August, 1973. 2 fig, 3 tab, 6 ref.

Descriptors: Nitrogen, Farm wastes, Crop response.
Identifiers: Land disposal, Millet, India.

This study discusses the response of early (95 days and below) and short (95-115 days) duration finger millet varieties to the application of graded doses of nitrogen and farm yard manure. The trial was conducted at Millets Breeding Station, Agricultural College and Research Institute, Coimbatore during 1965-1968. The manurial trial was a failure during the 1967 monsoon season due to severe drought and incidence of pests and diseases. Among the millet varieties viz., CO.8, AKP.2, CO.10, and EC.4841, the strain CO. 10 and selection EC.4841 recorded 35.3 and 50.3 per cent higher yield than the standard strain CO.8. Early duration varieties recorded 24.1 per cent higher grain yield at 67.5 kg nitrogen level; beyond that there was a decline in yield. For the early duration finger millet varieties, the yield differences due to the application of farm yard manure were significant during the year 1968. Application of farm yard manure at 25 tonnes-ha caused a 9.1 per cent increase in grain yield over no farm yard manure treatment. The short duration varieties responded well to the application of graded levels of nitrogen even up to 112.5 kg nitrogen-ha. Interactions between different levels of nitrogen and farm yard manure and varieties were not significant in all the years and in combined analysis. (Penrod-East Central)

**2799 - A1, D2, E3 100**

## RETORTING FEEDLOT WASTES,

Science News, Vol. 102, No. 10, p. 153, September, 1972.

Descriptors: Feedlots, Organic wastes, Carbon, Fuels, Water pollution, Air pollution.
Identifiers: Retort system, Pyrolysis, Inert ash, Char, Water clarification, Soil conditioner, Texas Technological University.

A particularly serious problem in the area of water and air pollution is feedlot waste. Each steer produces 16 times the organic waste produced by a human being. If organic wastes enter waterways, they cause high biological oxygen demand; if they are incinerated, they cause air pollution. Researchers at Texas Technological University have developed a retort system which dries feedlot waste, then pyrolyzes it. The product is char, carbon and inert ash which can be used for water clarification, as fuel, or as a soil conditioner. If the system is scaled up to commercial size and automated, it would require only one or two men to operate. (Solid Waste Information Retrieval System)

**2800 - D1, E3 100**

## FUTURE ENERGY SOURCES FOR TRANSPORTATION,

College of Engineering, Drexel University, Philadelphia, Pennsylvania
C. W. Savery
Traffic Quarterly, Vol. 26, No. 4, p. 485-499, October, 1972. 7 tab.

Descriptors: Energy, Recycling, Animal wastes, Municipal wastes, Hydrogen, Ammonia, Sludge digestion, Fermentation, Anaerobic digestion, Methane, Carbon dioxide, Alcohols.
Identifiers: Transportation fuels, Agricultural wastes, Pyrolysis, Hydrocarbons.

Natural energy resources are being consumed at a terrific rate. In 1960, approximately 20 per cent of the total energy consumed in the United States was consumed in transportation—126,000 Btu per capita per day. On one hand transportation fuel sources must be conserved and synthetic fuels produced. Two of these fuels would be hydrogen and ammonia. The third type of fuel would be produced by recycling waste trash, animal wastes, and crop residues. The pyrolysis of municipal refuse offers a possibility of producing fuels. It is estimated that 500 to 700 Btu per capita per day would be produced by recovering gas from the sludge digestion process in the United States. Another source of hydrocarbon fuels is the digestion of animal wastes. About 50,000 Btu per capita per day could be produced from the annual total of animal waste production. Another category of recycling waste is agricultural crop residues. Two processes are possible—fermentation to make alcohol and anaerobic digestion to produce a combustible mixture of methane and carbon dioxide. About 25,000 Btu per capita per day could be produced. By altering the energy mix, recycling could thus produce 80,000 Btu per capita per day or about two-thirds of the amount of the transportation energy consumed in 1960. (Solid Waste Information Retrieval System)

**2801 - D4, E3 100**

## RESEARCH AND TECHNOLOGY

Water Resources Newsletter, Vol. 7, No. 5, p. 1-2, October, 1972.

Descriptors: Research and development, Recycling, Feeds, Fuels, Methane, Cattle, Drying, Poultry.
Identifiers: General Electric, Hamilton Standard.

General Electric, in an installation at Casa Grande, Arizona, is using one-cell microbes to digest cattle manure. The resulting biomass, after being dried and powdered, is a tasteless, odorless, nutritious feed for chickens or cattle. Hamilton Standard converts manure into livestock feed using bacteria already present. Enough methane is generated in the process to supply the heat and electricity needed for the operation. (Whetstone, Parker, and Wells-Texas Tech University)

**2802 - A1, D4, E3, F1 100**

## GOBAR-GAS PLANTS PROMISES AND PROBLEMS,

Assistant Director, G. G. S. Khadi and Village Industries Commission, 3, Irla Road, Vile Parle (West), Bombay
H. R. Srinivasan
Indian Farming, Vol. 23, No. 11, p. 29, 31, 33, February, 1974.

Descriptors: Fuels, Anaerobic digester, Organic wastes, Fertilizers, Fermentation, Economics, Methane, Carbon dioxide, Nitrogen, Nutrients, Environmental sanitation.
Identifiers: India, Gobar-gas plant, Gas production.

Because of the present shortage of fertilizer, kerosene and petrol in India, it appears that gobar-gas plants can play a major role in preventing the draining away of valuable foreign exchange used for chemical fertilizer and crude oil imports. The gobar-gas plant is an anaerobic digester used for fermenting organic wastes. The digestion is carried out submerged in water. The end products of the anaerobic digestion are (1) Gobar-gas (a mixture of methane, carbon dioxide and minute quantities of $H_2S$ and other gases) and (2) a blackish, odorless, readily drainable, innocuous substance rich in nitrogen and humus. While it is hoped that the gobar-gas can become an accepted source of fuel, there are still problems to be worked out. Since cattle-dung is a very slow fermentor, probably because it is poor in nutrients, some way is needed to collect the cattle urine as well. Also, as day temperatures go down, the gas production falls. The manure presents storage problems. Social adjustment to this new fuel source has posed a problem. It is hoped, however that these problems can be worked out. It is felt that the gobar-gas plant offers a markedly increased income from the farm due to more and better manure, coupled with better living conditions. The gobar-gas manure has given better yields in all crops when compared to farm-yard manure made from the same quantity of cattle dung. (Penrod-East Central)

## 2803 - A2, B1 400
### FEEDLOT POLLUTION: A SOLVABLE PROBLEM?,
South Dakota Farm & Home Research, Vol. 21, No. 2, p. 30-31, Spring, 1970.

Descriptors: Agricultural runoff, Water pollution, South Dakota, Feedlots, Land management, Precipitation (atmospheric)
Identifiers: Retention ponds.

While he was a civil engineering graduate student at South Dakota State University, Paul Thormodsgard did research on snow and rainfall runoff from certain feedlots. He deducted that good land management could be a more feasible answer to feedlot pollution than expensive waste treatment. He found that a large ditch and a plowed field between the feedlot and a stream diminished the waste runoff. He also suggested that waste introduced into a stream in times of flood may be diluted by the large amounts of water. Thormodsgard pointed out that feedlot runoff is related to type of precipitation and could be held in retention ponds or possibly in a plowed field until conditions are right for its release. (Sanders-East Central)

## 2804 - A5, B1, D2 100
### REMOVING THE SMELL FROM MANURE
Water and Waste Treatment, Vol. 15, p. 3A, March 1972.

Descriptors: Poultry, Feeds, Drying.
Identifiers: After-burner, Odor removal, Great Britain.

"Removing smells created by processing poultry manure has saved the world's largest operator in this field from closure." A British concern producing agricultural feed by drying the manure quickly at high temperature to preserve its protein value has added "after-burners" which heat the exhaust gases to 800 degrees C before releasing them to a 75-ft stack. "The system has proved 100 per cent effective." (Whetstone, Parker, & Wells-Texas Tech)

## 2805 - D1, E3 400
### FEEDLOT WASTE USABLE,
Poultry Meat, Vol. 23, p. 16, October, 1972.

Descriptors: Feedlots, Recycling, Feeds, Performance.
Identifiers: Fractionation, Building materials.

A two-step fractionation process for feedlot waste developed by the Agricultural Research Service, USDA obtains a fibrous residue, fifty per cent of the waste, which can be pressed into board or used as a nutrient for fungus that produces a fiber-digesting enzyme. Chicken feed treated with the enzyme has improved digestibility. The fungus itself is almost half protein. (Whetstone, Parker and Wells-Texas Tech)

## 2806 - A1, B2, E2 100
### AN ECOLOGICAL BLUEPRINT FOR TODAY,
Journal of Environmental Health, Vol. 34, No. 1, p. 36-39, July-August, 1971. 6 fig, 3 tab, 3 ref.

Descriptors: Waste disposal, Sampling, Chemical properties, Physical properties.
Identifiers: Land disposal, Spray irrigation, Application rates.

The recycling of human effluent and animal waste by spray irrigation was discussed. Ten acres of cropland and 12 acres of woodland were spray irrigated. Disposal of liquid manure was at the rate of 2 in. per week over a 10-acre tract of cropland which is equivalent to 20 acre-in. or 544,000 gal. Weekly sampling and testing from 32 stations in the spray irrigation area were performed for the presence of turbidity, temperature, dissolved oxygen, phosphates, nitrates, nitrites, pH, ABS, and chlorides. It was found that by taking effluent from agricultural wastes of 200 cows and spray irrigating the crops with this effluent, production was tremendously improved. By utilization of the nutrients and the water, tonnage per acre increased. It was found that animals prefer nutrient-irrigated crops, as the plants are more succulent and contain more phosphorus and other minerals than crops that are just watered. The establishment of a community using spray irrigation for handling sewage waste was also described. Results so far indicate that spray irrigation is an effective system. The waste is applied to croplands and woodlands instead of dumping it into streams and lakes. (Solid Waste Information Retrieval System)

## 2807 - D4, E3 100
### INCREASED PRODUCTION OF BIOGAS FROM COWDUNG BY ADDING OTHER AGRICULTURAL WASTE MATERIALS,
Division of Soil Science and Agricultural Chemistry, Indian Agricultural Research Institute, New Delhi, India.
R. D. Laura and M. A. Adnani
Journal of Scientific Food Agriculture, Vol. 23, p. 164-167, April, 1971. 3 fig, 4 tab, 8 ref.

Descriptors: Gases, Methane, Fermentation, Anaerobic conditions, Chemical properties.
Identifiers: Production rates, Agricultural wastes, India.

"It was found that the addition of nitrogenous materials, such as casein, urea or urine, increased the extent of decomposition of cowdung, resulting in higher gas production. The effect appears to be to the maintenance of pH 7 during fermentation. With the addition of urea of $CaCO_3$, materials such as dry leaves and cane sugar have yielded high proportions of methane in the gas mixtures and three additions also increased the rate of gas production by promoting anaerobic conditions in the medium. Addition of cellulose also increased the rate but the gas mixture obtained had a lower methane content." (McQuitty and Barber-University of Alberta)

## 2808 - A9, E3 100
### ABORTION IN CATTLE ASSOCIATED WITH THE FEEDING OF POULTRY LITTER,
Departments of Veterinary Science and Biology, Pennsylvania State University, University Park
L. C. Griel, Jr., D. C. Kradel, and E. W. Wickersham
The Cornell Veterinarian, Vol. 59, No. 2, p. 226-235, 1969. 3 tab, 7 ref.

Descriptors: Litter, Cattle.
Identifiers: Refeeding, Abortion, Dienestrol-treated feed, Estrogenic activity, Hormonal imbalance.

A study was made to determine the relationship between the feeding of poultry litter obtained from birds that had received dienestrol-treated feed and a series of abortions in a breeding herd of beef cattle. During the period in which the herd was receiving poultry litter, all animals exhibited a great deal of estrual behavior. Upon cessation of the feeding of the litter, this behavior completely disappeared, abortions ceased, and the remainder of the herd subsequently calved normally. While the exact biochemical mechanisms involved in the etiology of the abortions remain unsolved, the evidence indicated that some manner of hormonal imbalance may have been involved. Further work is needed to determine the interactions of all the factors present in this case in causing abortion in cattle. (Penrod-East Central)

## 2809 - A1, E3 100
### FLAVOUR OF BEEF FED ON DRIED POULTRY WASTE,
Agricultural Research Council, Meat Research Institute, Langford, Bristol BS18 7DY
D. N. Rhodes
Journal of Scientific Food Agriculture, Vol. 22, p. 436, August, 1971.

Descriptors: Cattle, Feeds.
Identifiers: Dried poultry wastes, Flavor.

"Indirect comparisons of beef roasts from steers fed on rations containing 25 per cent dried poultry waste and from control animals, taste panels were unable to distinguish between the two meats on the basis of odour or flavour." (McQuitty and Barber-University of Alberta)

## 2810 - A1, B1, E1 400
### LIVESTOCK WASTE: WHY WASTE IT?,
Agricultural Situation, October, 1971, p. 2-4.

Descriptors: Waste disposal, Livestock Economics, Lagoons, Dehydration.
Identifiers: Land disposal, Composting, Refeeding.

Methods of utilization or disposal of manure currently used or under investigation are described briefly. These include land disposal, lagoons, the Pasveer oxidation ditch, composting, dehydration, and animal feeding. (Whetstone, Parker, and Wells-Texas Tech)

## 2811 - A1, C2, C3, E3 100
### THE USE OF ANIMAL WASTES ON FERTILIZER,
Armstrong, D.W.
Journal of Agriculture (South Australia), Vol. 75, p. 178-184, 1972.

Descriptors: Fertilizers, Irrigation, Animal wastes, Nutrients, Feedlots, Chemical properties, Physical properties, Nitrogen, Odor, Agricultural runoff, Groundwater pollution.

Identifiers: Land disposal, Application rates, Australia.

The amounts of manure produced and its composition are discussed. Application rates should not exceed 300 lb of nitrogen per acre to avoid groundwater contamination and other detrimental effects. Application of more than 100 lb per acre is useless. If manure is used for irrigation it should be diluted with water. Odor and runoff can create difficulties. (Whetstone, Parker, and Wells-Texas Tech)

### 2812 - A1, B2, E2 100

### PHOSPHORUS IN PERCOLATES FROM MANURED LYSIMETERS,

Department of Land Resource Science, University of Guelph, Guelph, Ontario, CANADA
D. G. Bielby, D. A. Tel, and L. R. Webber
Canadian Journal of Soil Science, Vol. 53, No. 3, p. 343-348, August, 1973. 3 tab.

Descriptors: Phosphorus, Percolation, Lysimeters.
Identifiers: Liquid poultry manure.

The objective of this report was to determine if phosphorus from heavy surface applications of liquid poultry manure would be retained by the soil or would occur in the percolates. Over the 3-year study period, the phosphorus added in the treatments was equivalent to 50, 408, and 1,240 and 1,590 kg/ha. During this period, the percolates contained the equivalent of 0.35, 0.65, 0.38, and 0.35 kg of P/ha for the four treatments respectively. The corresponding concentrations of phosphorus in the percolates were 0.029, 0.057, 0.033, and 0.034 mg/l. Although abnormally large amounts of phosphorus were added, the amounts found in the percolates were not correspondingly large. The study confirms the general observation that applied phosphorus tends to remain immobile in the soil. As the water moves through the subsoil, phosphorus attenuation occurs. (Penrod-East Central)

### 2813 - A1, E2 100

### CORN RESPONSE AND SOIL NITROGEN TRANSFORMATIONS FOLLOWING VARIED APPLICATION OF POULTRY MANURE TREATED TO MINIMIZE ODOR,

Research Station, Research Branch, Agriculture Canada, St. Jean, Quebec J3B 6Z8
K. A. MacMillan, T. W. Scott, and T. W. Bateman
Canadian Journal of Soil Science, Vol. 55, No. 1, p. 29-34, February, 1975. 4 fig, 3 tab, 14 ref.

Descriptors: Crop response, Corn, Poultry, Waste treatment, pH, Nitrification, Ammonification.
Identifiers: Land disposal, Nitrogen transformations.

The objective of this study was to examine the interrelationship between soil nitrogen transformations and corn response, following soil application of manure previously treated to minimize odor. Maximum above-ground yields obtained on Mardin and Honeoye silt loam were 54 and 23 g, respectively, whereas check yields were 9 and 8 g, suggesting that N additions had a greater influence on yield response under acid pH conditions. There were no visible signs of nutrient deficiency in plants from either soil, suggesting that nutrient supply was adequate. As a result of more favorable conditions for nitrification and $NH_3$ volatilization at the higher pH (Honeoye) as opposed to the acid pH (Mardin), there were differences in $NH_4$ plus concentrations between the two soils. The overall increases in $NO_3$—(Honeoye) and $NH_4$ plus concentrations during the course of the experiment indicated that the high N loading rates used were not toxic to the soil microorganisms at each pH value. On consideration of yield response as it related to measured soil N fractions, it was observed that NH positive and NO negative were the major N fractions used by the plants in the acid and neutral soil, respectively. Concentration of $NO_2$- toxic to corn was attributed as causing the substantial yield decreases with the higher rates of OD on the Honeoye soil. The study concluded that the major factor thought responsible for different N concentrations and ultimate corn yield response in each soil was soil reaction. (Penrod-East Central)

### 2814 - B1, D2, D3, E3, F1 400

### CONVERSION OF SWINE MANURE TO PROTEIN,

Department of Soil Science, Oregon State University, Corvallis, Oregon
Larry Boersma
Feedstuffs, Vol. 47, No. 39, p. 20-21, September 22, 1975. 1 fig, 3 tab.

Descriptors: Recycling, Algae, Proteins, Feeds, Economics, Energy, Methane.
Identifiers: Swine.

Oregon State University is experimenting with the use of swine manure as a substrate for growing algae, which may then be used as feed. The economics of such recycling is dependent upon such variables as water temperature, light intensity, depth of culture and retention time. Two harvesting methods were employed: (1) centrifugation and (2) precipitating the material with alum. The algal material obtained by centrifugation was a good source of protein. Alum precipitated algae did not give good results, strongly suggesting that harvesting should be done by centrifugation, air flotation, or some other method which does not add toxic materials. The development of an inexpensive method for harvesting algae has been a major deterrent to the development of commercial algal production. Centrifugation is expensive and energy intensive. It is hoped that methane, which is produced in the initial digestion of the manure, may be used as the energy source. Current experimentation at Oregon State is focused on determining optimum management techniques. (Cannon-East Central)